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Are current sleep hygiene strategies effective for individuals with chronic pain? A scoping review

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Title: Are current sleep hygiene strategies effective for individuals with chronic pain? A scoping review

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ABSTRACT

Objectives: Up to a quarter of the world’s population experience chronic pain, which, in addition to interfering with daily activities and waking function, is often associated with poor sleep. A bidirectional relationship exists between pain and sleep: poor sleep can result in increased perceived pain, and pain can result in poorer sleep quality and duration. Individuals experiencing poor sleep are often encouraged to implement lifestyle, environmental, and behavioural strategies to promote healthy sleep. These strategies are collectively termed sleep hygiene. However, current sleep hygiene strategies have not been developed considering the unique challenges faced by individuals with chronic pain and therefore they might not be as effective in this population.

Design: This scoping review included a search of four online databases (Medline, Embase, PSYCInfo, and CINAHL) to identify articles examining the use and effectiveness of sleep hygiene strategies in populations with chronic pain.

Results: Thirty articles investigated at least one sleep hygiene strategy in individuals with chronic pain, with evidence found to support the use of six sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment). However, as the timing of these strategies was often not reported, the degree to which these strategies are effective as a pre-sleep strategy is unknown.

Conclusion: While sleep hygiene strategies may be used by people living with chronic pain and are often recommended by professional bodies for this population, there is limited evidence to support the effectiveness of all strategies. The efficacy of sleep hygiene practices in different chronic pain sub-populations should be the focus of future research in order to develop tailored strategies for individuals with chronic pain.

Strengths and limitations of this study

- This is the first study to investigate the efficacy of sleep hygiene strategies in chronic pain populations
- A strength of this review was the scoping review methodology which allowed for exploration of the literature to identify key gaps
- A full systematic search strategy was not conducted due to the aims of the study, as such, studies of lower quality may be included.
- The terminology used to discuss sleep hygiene varied greatly amongst the included studies which may have resulted in studies missed.

KEYWORDS

Pain management, Sleep Medicine, Back pain

INTRODUCTION

Chronic pain is pain existing or reoccurring for longer than three months and is multifactorial, having social, biological, and psychological attributes ^{1 2}. Globally, chronic pain is the leading cause of disability and disease burden ³, affecting between one-third and one-half of the population in the United Kingdom, United States and Australia ⁴. In addition to the economic burden of chronic pain, there can be a significant personal cost. Difficulty in mobilisation, an increased likelihood of depression, a reduction in quality of life, and an increased need for healthcare are all common experiences for individuals experiencing chronic pain ⁵. Another common issue for those experiencing chronic pain is poor sleep, that is, disturbed sleep quality and quantity ⁵.

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The relationship between poor sleep and chronic pain is well documented ⁵⁻⁷. Individuals with chronic pain generally report poorer sleep quality ^{8 9} and quantity ⁸⁻¹⁰ compared to those without chronic pain. This is problematic, as sleep is a biological need, with 7-9 hours of sleep per night recommended for adults for optimal health and wellbeing ¹¹. Poor sleep is associated with poorer physical and psychological health outcomes ^{13 14}, in addition to impaired cognition, memory, attention, and alertness ^{5 15 16}. Thus, there are likely to be far reaching benefits of improving sleep in individuals experiencing chronic pain.

The relationship between sleep and pain is bi-directional ^{17 18}, such that chronic pain can lead to poor sleep and poor sleep can increase the perception of pain. For example, studies have found that even one night of disrupted sleep can increase the perception of pain ⁶. Conversely, adequate night-time sleep appears to be predictive of less pain and may assist individuals to cope with chronic pain ^{5 7}. This further highlights the need to reduce the prevalence of poor sleep in this population and the importance of incorporating strategies to improve sleep into current treatment and management approaches for chronic pain. While there are various strategies to manage chronic pain ²⁰, historically, medication is the most common treatment for pain symptoms ²¹⁻²³. However, some pain medications can impact sleep ²⁴⁻²⁶ and people with chronic pain have a higher risk of substance abuse ²⁷. Evidence is growing to support a multidisciplinary approach to pain management using a biopsychosocial framework ²⁷. Consequently, other strategies are being utilised to manage sleep and pain, including behavioural, non-pharmacological strategies ^{27 28}. One such behavioural strategy is sleep hygiene.

Sleep hygiene can be described as healthy sleep practices, including lifestyle, environmental and behavioural strategies ²⁹⁻³¹. A set of sleep hygiene guidelines was proposed by Mastin, et al. ³², and promoted by the Australasian Sleep Association and the Sleep Health Foundation ^{33 34}. An overview of sleep hygiene strategies is presented in Table

1. Improving sleep hygiene has been shown to improve sleep in a range of populations including students^{35 36}, older adults³⁷⁻³⁹, athletes^{40 41}, and individuals with sleep disorders such as insomnia⁴². However, there are limitations to our current understanding of the effectiveness of sleep hygiene strategies. In particular, there are no current evidence-based guidelines on the use of sleep hygiene strategies in individuals living with chronic pain.

Table 1. Sleep hygiene strategies (adapted from Mastin et al. 2006)

Sleep hygiene strategy
Avoid daytime naps lasting two or more hours
Go to bed at the same time each day
Get out of bed at the same time each day
Avoid exercising to the point of sweating within 1h of going to bed
Avoid staying in bed longer than you should two or three times a week
Avoid anything that may alert you before bedtime
Avoid going to bed feeling stressed, angry, upset, or nervous
Avoid using your bed for things other than sleeping or sex
A comfortable bed
A comfortable bedroom (temperature, light, noise)
Avoid important work before bedtime
Avoid thinking, planning, or worrying when in bed

Given the association between chronic pain and poor sleep, and the trend toward behavioural strategies being recommended for sleep improvement, it is critical to understand

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the effectiveness of sleep hygiene strategies in this population. While guidance on the use of sleep hygiene strategies is readily available for people living with chronic pain as part of free online resources for chronic pain management ⁴³⁻⁴⁵, to date, no study has investigated whether the sleep hygiene guidelines are useful for improving sleep in this population.

This scoping review aims to explore whether sleep hygiene strategies have been investigated in chronic pain populations, and how effective each strategy is for improving sleep. Scoping reviews are considered an ideal tool to determine the scope of a body of literature ⁴⁶. Thus, a scoping review was chosen to allow the research team to explore the literature that currently exists in the area of sleep hygiene strategy use in individuals experiencing chronic pain and identify specific gaps in the literature. This scoping review is the first step in understanding whether sleep hygiene strategies are effective in a chronic pain population.

METHODS

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis – Scoping Reviews (PRISMA-ScR) guidelines were followed for this review ⁴⁷. A search was performed using the databases Medline, Embase, PSYCInfo, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Searches were performed of peer reviewed abstracts within all databases. Search terms included ‘sleep’ and ‘chronic pain’ and a series of terms covering components of sleep hygiene. Search terms used (with slight differences based on database requirements) were:

Sleep AND “chronic pain” AND (“sleep hygiene” OR napping OR
bed time OR wake time OR exercise OR alcohol OR tobacco OR
smoking OR caffeine OR alert* OR activity OR emotion* OR mood

OR sex OR bed OR bedding OR light OR heat OR cold OR
 temperature OR noise OR sound OR work OR worry OR rumination
 OR stress OR routine)

Search terms were chosen to align with established sleep hygiene strategies. See Table 2 for an overview of strategies and aligned search terms.

Table 2. *Sleep hygiene strategies and aligned search terms*

Sleep hygiene strategy	Search terms
Napping	Napping
Consistent bed and wake time	Bed time OR wake time
Pre-bed exercise	Exercise
Alcohol	Alcohol
Tobacco	Tobacco OR smoking
Caffeine	Caffeine
Pre-bed alerting activities (e.g., video games, internet)	Sleep hygiene OR alert* OR activity
Pre-bed state (e.g., stress, anger, worry, rumination)	Emotion* OR mood OR worry OR rumination OR stress
Use of bed for activities other than sleep or sex	Activity OR sex
Uncomfortable bed/bedding	Bed OR bedding
Sleep environment (e.g., light, heat)	Light OR heat OR cold OR temperature OR noise OR sound
Pre-bed work	Work
Pre-bed routine	Routine

Reference lists were also hand-searched to identify any additional articles that were not included in the initial search.

Eligibility criteria

The PICO structure was used to develop the key inclusion criteria for this review (Population, Intervention, Comparison, Outcome) (Higgins et al., 2021). See Table 3 for the PICO strategy.

Table 3. *Cochrane PICO strategy*

Population	Intervention	Comparison	Outcome
Chronic pain population of any kind	Sleep hygiene intervention (refer to Table 1)	No comparison required. Typically, a control group where no intervention is used.	A minimum of one sleep outcome (subjective and/or objective measures)

To be included in this literature review, articles were required to be published in a peer reviewed journal (i.e., no industry reports or grey literature were included). No limits on the year of publication were included. Case studies and reviews were excluded, as were studies that were not written in English. Articles were required to include at least one sleep hygiene intervention with a population experiencing chronic pain of any kind, and a minimum of one subjective or objective measure of sleep was required.

Data charting

Data extracted from the included articles included year of publication, authorship team, location, study design, population, and study setting. Additionally, the aspect(s) of sleep hygiene that each article addressed was identified (e.g., caffeine use, pre-bed routines). Results were then synthesised by sleep hygiene strategy.

RESULTS

Selection of sources of evidence

Searches identified a total of 946 peer reviewed journal articles (after duplicate removal) that were screened based on title and abstract. Full text review was performed of 88 journal articles, of which 30 met the criteria for inclusion. See Figure 1 for an overview of screening procedures (PRISMA flowchart). Full text screening was performed by authors MS and SF. Any discrepancies were resolved by consulting with a third author (CG).

INSERT FIGURE 1

Characteristics of sources of evidence

Study design, location, year of publication, population, study setting, and outcomes are presented in Table 4 (Supplementary file 1). The following strategies had associated articles: alcohol use (n = 2), exercise (n = 10), light (n = 1), pre-bed state (n = 11), tobacco use (n = 3), and sleep hygiene education (n = 1). An additional two papers included both measures of sleep hygiene and sleep in a chronic pain population. No studies were found addressing any other sleep hygiene strategies in a chronic pain population.

Chronic pain populations included individuals with fibromyalgia (n = 3), non-specified chronic pain (n = 6), non-cancer related chronic pain of any kind (n = 4), chronic spinal pain

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(n = 1), chronic benign neck, low back and/or generalised pain (n = 2), chronic low back pain (n = 2), musculoskeletal chronic pain (n = 3), back pain, osteoarthritis, and/or rheumatoid arthritis (n = 1), Failed Back Surgery Syndrome (n = 1), chronic knee pain (n = 1), sickle cell disease (n = 1), orofacial pain (n = 1), chronic rheumatic conditions (n = 2), cancer (n = 1), and Parkinson’s disease (n = 1).

Synthesis of results

Each sleep hygiene strategy for which studies were identified is discussed. The strategies are listed based on most evidence from the literature to least evidence.

Pre-bed state

Eleven studies examined pre-bed state and sleep outcomes in patients with chronic pain⁴⁸⁻⁵⁸. There was methodological heterogeneity amongst these 11 studies. Of the studies that utilised a cross-sectional design, two investigated the impact of pre-sleep arousal on scores on the Insomnia Severity Index in participants with chronic pain^{50 52}. Both studies demonstrated that higher scores on the Insomnia Severity Index, indicating impaired sleep, were associated with greater pre-sleep arousal. The study by Zaidel, et al.⁵⁸ used a cross-sectional design in older adults (>65 years old) diagnosed with chronic pain and reported that higher daily stress was associated with poor sleep quality and quantity. Daily stress was also associated with poor sleep quality in a sample of children diagnosed with sickle cell disease⁵⁷.

Mindfulness and meditation were also common amongst the studies that addressed pre-bed state and sleep^{48 53 54 56}. Mindfulness programs were assessed in populations of patients with chronic non-cancer pain⁴⁸, failed back surgery syndrome⁵³, chronic knee pain⁵⁴, and chronic low back pain⁵⁶. There were mixed findings, with some studies identifying less sleep

disturbance post-mindfulness intervention ^{48 56}, and the remaining two studies showing no benefit of mindfulness on sleep compared to a control condition ⁵³ or listening to music ⁵⁴.

Relaxation was also investigated as a pre-bed state strategy ^{49 51 55}. Findings were again mixed with improvements in subjective sleep quality seen after using progressive relaxation in a sample of 19 participants with chronic pain ⁵¹ and in a sample of 36 participants with chronic back or joint pain ⁵⁵. Conversely, no improvement in sleep quality was seen in a sample of 12 participants with musculoskeletal pain who completed a pre-bed relaxation intervention ⁴⁹.

Exercise

Ten studies assessed exercise as a sleep hygiene strategy, with mixed findings. Decreases in insomnia severity ^{59 60}, decreases in sleep problems ⁶¹, and increases in sleep quality ^{62 63} were found after some exercise interventions to increase activity during the day in participants living with chronic pain. Other studies however, found that higher daytime activity was associated with either no change in insomnia symptoms ⁶⁴, poorer sleep quantity and quality in individuals with chronic pain ⁶⁵⁻⁶⁷.

Tobacco

Three studies investigated tobacco use and sleep outcomes in patients with chronic pain ⁶⁸⁻⁷⁰. Cross-sectional study designs were used in all three studies, with both Burris, et al. ⁶⁹ and Khan, et al. ⁶⁸ doing retrospective reviews of clinical care data from patients experiencing chronic pain. In both studies sleep disturbance was significantly worse in participants that smoked compared to those that didn't, as measured by the PSQI ⁶⁹ and a sleep-related question from the Patient-Reported Outcome Measurement information System ⁶⁸. Similar results were seen in the study conducted by Stipelman, et al. ⁷⁰, with data from a National Health Interview Survey. Smokers were more likely to have short sleep duration (<6h) compared to non-smokers in a sample of 22, 850 patients with chronic rheumatic conditions.

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Sleep hygiene

Two studies measured the relationship between the use of ‘sleep hygiene practices’ as a whole and sleep outcomes in individuals with chronic pain ^{71 72}. Emery, et al. ⁷² conducted a study in which 60 participants completed a survey including the Sleep Hygiene Awareness and Practice Scale and the Pittsburgh Sleep Quality Index (PSQI). They found that participants with musculoskeletal chronic pain reported better sleep hygiene than those with comorbid major depressive disorder and musculoskeletal pain. However regardless of sleep hygiene use, all participants had poor sleep onset latency and sleep quality. Likewise, in a study of adolescents with and without chronic pain ⁷¹, those with chronic pain had poorer sleep quality despite a similar use of sleep hygiene amongst participants.

Alcohol

Alcohol use and sleep was investigated in samples of patients with chronic pain in two studies ^{73 74}. Graham and Streitel ⁷³ had 108 college students with any reported type of chronic pain complete a survey about alcohol use and sleep and found that increased alcohol use was associated with poorer sleep. Similarly, Miller, et al. ⁷⁴ found that an increase in alcohol consumption resulted in increased sleep latency in a sample of 23 students with fibromyalgia who completed 14-day alcohol and sleep diaries.

Education

One study was identified that investigated the influence of education about healthy sleep as a sleep hygiene strategy ⁷⁵. Berry et al. (2015) conducted a randomised controlled trial with 85 participants with chronic non-cancer pain and found that a four-week sleep hygiene education program improved sleep onset latency in people living with chronic pain compared to a control group of people living with chronic pain who did not receive the same education program.

Sleep environment

Only one study identified in this review investigated optimising the sleep environment ⁷⁶.

Morning bright light was used in 37 participants with chronic back pain for 13 days. It was found that subjective sleep quality improved post-bright light treatment, compared to pre-treatment.

No evidence found

No studies included in this review presented information on napping, consistent bed and wake times, caffeine use, pre-bed activities (not mood related), bed and bedroom use, uncomfortable bed/bedding, pre-bed work, or pre-bed routines.

Discussion

The aim of this scoping review was to investigate whether sleep hygiene strategies have been investigated in chronic pain populations, and how effective each strategy is for improving sleep. Together, these studies suggest that while sleep hygiene strategies may be used by people living with chronic pain ^{77 78}, there is limited evidence to support the effectiveness of some strategies. This is a particularly important finding given that sleep hygiene strategies are commonly recommended for those with chronic pain as part of behavioural treatments ⁷⁹.

Studies were found that supported the use of six specific sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment), the most promising of which appear to be management of pre-bed state and use of daytime exercise. Standard sleep hygiene advice relating to pre-bed state highlights the need to avoid thinking, planning and worrying before sleep ³². The 11 identified studies that addressed pre-bed state suggest that using strategies such as relaxation ^{49 51}, mindfulness ^{48 53}, and meditation and music ⁵⁴ can improve sleep quality and decrease sleep disturbance in people with chronic pain. However, it must be noted that many of the included studies did not

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require these relaxation strategies to be performed immediately prior to bed (i.e., these activities were performed at any time of day). It is possible that the impact of these activities on pre-bed state (and potentially on subsequent sleep) would be greater if performed within the context of a specific sleep hygiene intervention (i.e., if relaxation or mindfulness activities were performed in the hour or two before bed). Further, given that chronic pain is typically associated with high levels of stress and anxiety ⁸⁰, it is likely that interventions designed to improve pre-bed state may be of particular importance for improving sleep in this population ⁸¹.

Conflicting results were found for exercise as a sleep hygiene strategy in people with chronic pain. Given that there was a high level of heterogeneity in the types and duration of exercise measured in each study, specific recommendations cannot be made for the optimal type or duration of exercise for improving sleep in individuals with chronic pain. It is also likely that the effectiveness of exercise as a strategy for improving sleep differs based on the type of chronic pain experienced by the individual, as well as the type of exercise (e.g. high intensity vs low intensity). This corresponds to previous literature showing that overactivity can exacerbate symptoms of chronic pain ⁶⁵. Further, it is important to note that while the sleep hygiene guidelines by Mastin, et al. ³² recommend avoiding exercise within one hour of going to bed, a recent systematic review and meta-analysis of 23 articles found that overall, evening exercise did not influence sleep quality ⁸². Given that the exact timing of exercise was not investigated in the studies identified in the present review, it is unknown if there is an optimal time of day to exercise for people living with chronic pain in relation to sleep outcomes. As such, there is a need for future research to address both the timing, type and duration of exercise used by individuals with different types of chronic pain when considering the impact on subsequent sleep. This research will inform targeted recommendations for exercise as a sleep hygiene strategy for individuals with chronic pain.

Alcohol and tobacco intake was also investigated in the reviewed studies, with sleep disturbances in individuals with chronic pain associated with increased tobacco use and alcohol use^{68-70 73 74}. Of note however, is that the sleep hygiene recommendation is to avoid these substances in the four hours prior to bed³². In the studies included in this review, however, overall daytime consumption of alcohol or tobacco was measured rather than specific timing of consumption (i.e., whether alcohol/tobacco were consumed close to bedtime). Therefore, timing of alcohol and tobacco use, rather than restriction of alcohol use, is the critical question in the context of a sleep hygiene strategy and should be considered within future research. This research is particularly important given that alcohol may negatively interact with pain medications⁷³, and tobacco can contribute to higher pain intensity⁸³. Furthermore, alcohol has reportedly been used to self-medicate in some individuals with chronic pain⁸⁴, and there may therefore be reluctance to decrease or stop use in the absence of a pain management alternative.

Despite the support for the use of certain sleep hygiene strategies in individuals with chronic pain, caution must be taken when recommending these strategies. Firstly, there are diagnosis-specific characteristics found in different chronic pain conditions⁸⁵. For example, people with nociplastic conditions such as fibromyalgia or complex regional pain syndrome are known to have higher sensory sensitivity, and suffer from fatigue and insomnia more than people with other pain conditions²⁷. This is likely to influence the efficacy of sleep hygiene strategies for this specific chronic pain population. Further, it is likely that were these sleep hygiene strategies to be recommended, some modifications may be necessary to tailor the recommendations for individuals with chronic pain. For example, one sleep hygiene strategy involves avoiding alerting activities before bedtime, such as the use of a mobile phone, internet, or video games. However, such tasks have been shown to be a distraction from pain symptoms^{86 87}. Therefore, a suggestion to avoid these tasks before bed may increase

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awareness of pain symptoms before bed which would have a negative impact on sleep. A pre-bed activity that is distracting from pain but not alerting may be an appropriate alternative for individuals with chronic pain. Modifications such as this should be considered for all sleep hygiene strategies.

No studies investigated the use of the remaining eight sleep hygiene strategies (pre-bed work; pre-bed routine; use of bed for activities other than sleep or sex; uncomfortable bed or bedding; caffeine; pre-bed alerting activities; napping; and consistent bed/wake times). A priority for future research is to investigate the efficacy of these strategies for improving sleep in chronic pain populations. An important first step could be to investigate the caffeine-related strategy, as caffeine is known to play a role in pain management due to the adjuvant analgesic effects^{88 89}. Much like alcohol and tobacco, caffeine is best avoided in the four hours prior to bed according to the general sleep hygiene guidelines ³². However, no studies assessing this strategy in a chronic pain population were identified in this review. Further, several studies have highlighted that those with chronic pain consumed significantly more coffee than those without chronic pain ⁹⁰⁻⁹². This highlights the need for further investigation of the relationship between caffeine use, chronic pain, and sleep, given the high amount of use of caffeine in a chronic pain population.

The limitations of this review must be acknowledged. This is a scoping review, designed to overcome the evidence bias that may be present in a narrative review but with a broader search than a systematic review in order to understand a wider research area ⁴⁶. A full systematic strategy that involves assessing risk of bias was not conducted given the heterogeneity of the literature. It is therefore possible that studies of lower quality (than would otherwise be included in a systematic review) were included. Additionally, a limitation of the search strategy is that terminology used to discuss sleep hygiene throughout the literature was not consistent and many studies did not use the term sleep hygiene. While the

search strategy was widened to include terms relating to specific strategies, it is possible that some articles were missed.

The review highlights that while sleep hygiene is promoted as a non-pharmacological strategy for improving the sleep of those with chronic pain, there is a lack of research into the efficacy of these strategies in individuals with chronic pain. While creating, evaluating, and promoting targeted sleep hygiene guidelines for people living with chronic pain is a goal, more research is needed. Firstly, assessment of the efficacy of current sleep hygiene strategies in individuals with chronic pain is required. Specifically, certain activities (e.g., exercise) would ideally be investigated in the context of the pre-bed period, taking account of timing. While research on some sleep hygiene strategies was identified, only tentative support could be provided due to the heterogeneity of type and duration of interventions used. Therefore, studies should be designed to evaluate the efficacy of certain sleep hygiene strategies in individuals with chronic pain. The differences between chronic pain conditions must also be considered. Finally, qualitative approaches will be critical in understanding the lived experience of chronic pain and the use of sleep hygiene strategies.

This scoping review explores the current literature addressing sleep hygiene in individuals experiencing chronic pain. Limited literature was identified, and while some strategies show promise for improving sleep in people living with chronic pain, the timing of the strategy use/implementation was not examined. Given the relationship between sleep quality and pain, as well as the fact that sleep hygiene is commonly promoted to people with chronic pain, future research into the efficacy of sleep hygiene programs is needed. This is necessary to ensure that advice given to people living with chronic pain is evidence-based and will lead to improvements in sleep.

Ethical approval: This study does not involve participants and ethical approval was not required.

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Conflict of interest: The authors declare no conflicts of interest.

Data sharing: Data sharing not applicable as no datasets generated and/or analysed for this study.

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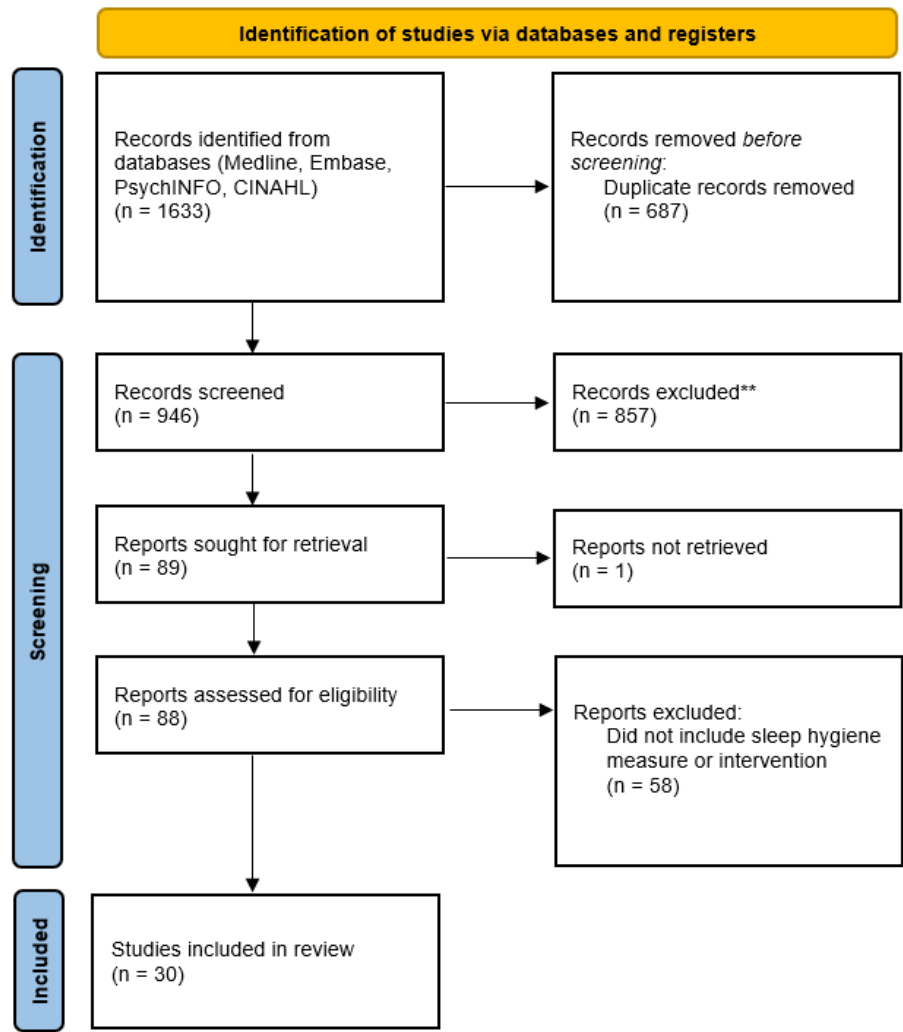


Figure 1. Screening process

Table 4. Data charting table

Sleep hygiene-related strategy	Author	Year	Location	Study design	Population and study setting	Findings
All sleep hygiene strategies	Emery et al.	2014	Canada	Multi-component study including qualitative interviews, cross-sectional survey, and observational data	Cross-sectional component of study included the completion of the SHAPS, PSAS, and the PSQI. Participants also completed daily sleep diaries. Participants with and without major depressive disorder were compared. N = 60	PSQI ($p > 0.10$) MDD group: 15.48(± 3.68) Non-MDD group: 14.84(± 4.06) SHAPS ($p = 0.06$) MDD group: 35.61(± 15.30) Non-MDD group: 28.31(± 13.80) PSAS – somatic ($p = 0.070$) MDD group: 16.38(± 5.12) Non-MDD group: 14.12(± 4.27) PSAS – cognitive ($p = 0.009$) MDD group: 21.11(± 7.66) Non-MDD group: 16.44(± 5.30)
	Walker et al.	2010	United States	Cross-sectional observational design	A population of adolescents receiving chemotherapy treatment for cancer completed a questionnaire and a 7-day sleep diary (N = 51). Findings were compared to previously published findings from a healthy sample (N = 20). Participants completed the ASHS.	Physiological subscale ($p > .05$) Cancer group: 4.7(± 0.7) Healthy controls: 4.9(± 0.8) Cognitive subscale ($p \leq .001$) Cancer group: 3.9(± 0.8) Healthy controls: 4.4(± 0.6) Emotional subscale ($p > .05$) Cancer group: 4.7(± 1.1)

Healthy controls: 4.8(±1.1)

Sleep environment subscale (p≤.001)
Cancer group: 5.0(±0.9)
Healthy controls: 5.5(±0.6)

Substances subscale (p>.05)
Cancer group: 5.9(±0.5)
Healthy controls: 6.0(±0.1)

Sleep stability subscale (p≤.001)
Cancer group: 3.7(±1.1)
Healthy controls: 4.3(±0.7)

ASHS total score (p≤.001)
Cancer group: 4.7(±0.5)
Healthy controls: 5.0(±0.4)

Sleep education					
Berry et al.	2015	Canada	Between-subject randomised controlled trial	Intervention group with one-on-one didactic session including practical steps for improving sleep, control group. Performed in a population with chronic non-cancer pain. N = 85	Sleep latency (week 4)* (p < .02) Sleep hygiene group: 93.9 (±42.6) mins Control group: 118.4 (±45.1) Sleep quality (week 4) Sleep hygiene group: 2.8 (± 0.8) Control group: 2.9 (±0.7) Time in bed (week 4) Sleep hygiene group: 7.5 (±1.6)

Control group: 7.2 (± 1.1)**Napping - no articles found****Consistent bed and wake time - no articles found****Exercise**

Andrews et al.	2014	Australia	Observational, prospective, within-person study design	Activity monitor and questionnaire completion over five days in individuals with non-cancer related chronic pain N = 50	Higher daytime activity associated with greater overnight wakefulness ($\beta = .29$, $t_{88.84} = 2.09$, $P = .04$, 95% CI = 0.0015 to 0.06)
Asih et al.	2014	United States	Prospective within-subject study design	Quantitatively directed exercise progression program including approximately 4-6h activity per day over 4-8 weeks. N = 481 patients with chronic disabling occupational musculoskeletal disorders	53.4% of participants moved to a lower category on the Insomnia Severity Index at the end of treatment.
Evans et al.	2013	United States	Exploratory randomised usual-care waitlist-control design	Participation in yoga program (N = 11) compared with waitlist control group (N = 15) in women with rheumatoid arthritis. Data collected at three timepoints (baseline, post-treatment, 2 month follow up)	No significant differences in sleep outcomes for participants in the yoga group ($p = .100$)
Hall et al.	2019	United States	Prospective baseline, pre- and post-intervention	Participation in a 10-week yoga program, with baseline, pre- and post-intervention measures including the SPI II. One third of	SPI II Baseline (N = 33): 50.9 ± 21.3 Pre-intervention (N = 27): 49.4 ± 20.5

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			design	participants (N = 11) completed pre- and post- intervention measures.	Post-intervention (N = 11): 37.9 ± 23.1
Jones et al.	2012	United States	Parallel-group randomised controlled trial	8-form Yang-style Tai chi program compared to an education control N = 101 individuals diagnosed with fibromyalgia	PSQI global score Tai chi group: -2.0 points Control group: 0.03 points
McGovney et al.	2020	United States	Observational, prospective, within-person study design	14-day baseline data collection portion of insomnia trial in individuals with fibromyalgia N = 160	Actigraphy Reduced total sleep time, sleep latency, wake after sleep onset, and sleep efficiency after afternoon activity, (p < .001 for all variables), and early evening activity, (p < .001 for all variables)
Nguy et al.	2020	Australia	Observational cross-sectional design	Participants with Parkinson's disease completed a week of objective physical activity and sleep monitoring and subjective sleep and pain measurement (N = 52)	Increased physical activity associated with increased pain (p<.05) Poor sleep associated with increased pain (p<.05)
Skarpsno et al.	2018	Norway	Longitudinal design	Historical data of a sample of the general population including measures of chronic pain, physical activity, and insomnia (N = 36,984)	No combined effect of physical inactivity and ≥5 pain sites on risk of insomnia (RERI: 0.88 (95% CI: -.085, 2.60)) With 1-4 pain sites, physical activity resulted in a lower risk of insomnia (p<0.05).

	Tang et al.	2014	United Kingdom	Observational cross-sectional design	Sleep and physical activity monitoring over a week period in participants with chronic pain (N = 119)	Sleep quality predicted physical activity (p= .017)
	Wicklund et al.	2018	Sweden	Randomised controlled trial	Comparison of exercise intervention, stress management intervention, and control conditions. Population including individuals with chronic benign neck, low back and/or generalised pain. N = 299	Post-intervention ISI *= significantly different from baseline measurement (p<.05) Exercise group: 11.19 ± 6.27* Stress management group: 12.22 ± 6.38* Control group: 12.59 ± 7.13
Alcohol use						
	Graham & Streitel	2010	United States	Cross sectional design	Survey administered to college students with any reported type of chronic pain N = 108	Alcohol use predicted poor sleep quality b = .29, p<.01
	Miller et al.	2018	United States	Observational, prospective, within-person study design	14-day daily alcohol and sleep diary in individuals with fibromyalgia N = 23	Each alcoholic drink consumed resulted in an increased sleep latency of 5.0 minutes.
Tobacco use						
	Burris et al.	2013	United States	Cross-sectional design	Retrospective chart review new-patient examinations in a population with orofacial pain. N = 48	PSQI global score* (p>.05) Non-smokers: 1.44 (1.08) Smokers: 2.00 (0.93)
	Khan et al.	2019	United States	Cross-sectional design	Retrospective review of clinical care data in a general chronic pain population.	Sleep disturbances (PROMIS) significantly worse in smokers than non-smokers: p < .001

N = 8584

Stipelman et al.	2013	United States	Cross-sectional design	National Health Interview Survey data relating to a population with chronic rheumatic conditions. N = 22,850	Reported <6h sleep/night Smokers: 25.4 % Non-smokers: 15.2%
Caffeine - no articles found					
Pre-bed alerting activities (e.g., video games, internet) - no articles found					
Pre-bed state (e.g., stress, anger, worry, rumination)					
Brintz et al.	2020	United States	Mixed-methods, single-group, pre-post design	Mindfulness program evaluation in individuals with chronic noncancer pain. N = 23	Sleep disturbance* (p>.05) Pre-intervention: 56.52 (±7.79) Post- intervention: 51.83 (±9.75)
Brown et al.	2014	Canada	Case series study	Self-Shiatsu pre-bed relaxation intervention in individuals with a musculoskeletal condition resulting in chronic pain. N = 12	No significant differences in PSQI or actigraphy outcomes (no figures reported)
Byers et al.	2016	United States	Cross-sectional design	Survey completed by individuals with chronic pain (duration ≥6 months) N = 48	13% of variance in scores on ISI explained by cognitive and somatic scores on the PSAS (p=.001)
Chen & Francis	2010	Australia	Randomised controlled trial	Abbreviated progressive relaxation technique and guided imagery intervention (6 weeks) in individuals with any non-malignant chronic pain.	Sleep quality VAS ratings Intervention group: 75% of participants saw improvement Control group: 28.57% of participants saw improvement

				N = 19	
Dillon et al.	2012	United States	Cross-sectional	Inter-group comparison based on Insomnia Severity Index (ISI) scores in individuals with non-specified chronic pain. N = 32	PSAS item “worry about falling asleep”* (p<.05) Participants with moderate – severe ratings on ISI: 3.2(±1.6) Participants with mild ratings on ISI: 2.3(±1.2)
Esmer et al.	2010	United States	A single-center, prospective, randomized, singleblind, parallel-group clinical trial	8-week mindfulness-based stress reduction (MBSR) therapy compared with control in a population with Failed Back Surgery Syndrome. N = 25	Abridged PSQI Intervention group: 2.4 (±0.8) Control group: 2.3 (±0.9)
Innes et al.	2018	United States	Randomised controlled trial	Meditation and music listening conditions in a population with chronic knee pain. N = 20	PSQI global score (p = .23) Meditation group: 9.78 (±3.24) Music listening group: 8.09 (±2.21)
Linton et al.	1985		Three group pre- and post-test design	Comparison of waitlist control, regular treatment, and behavioural treatment (including applied relaxation) groups in a sample of participants with chronic back or joint pain. Outcomes included questions on sleep latency, quality, and number of awakenings, which were combined into one overall sleep outcome metric. (N = 36)	Significantly greater improvements seen in the behavioural treatment group compared with waitlist control (p=.020) and regular treatment (p=.049).

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Morone et al.	2008	United States	Qualitative design	Adults ≥65 years with chronic low back pain completed an 8-week mindfulness meditation program. Qualitative analyses were performed on a daily diary (N = 27)	Main themes: <ul style="list-style-type: none">• Pain reduction Improvement in attention skills <ul style="list-style-type: none">• Improved sleep• Wellbeing• Barriers to meditation• Processes of meditation
Valrie et al.	2007	United States	Prospective observational study	Daily diary study in children with sickle cell disease. N = 20	Greater stress during the day associated with shorter sleep periods ($\beta = -0.13, p = .04$)
Zaidel et al.	2021	United States	Cross-sectional design	Survey completed by participants aged ≥65 years with diagnosed back pain, osteoarthritis, and/or rheumatoid arthritis N = 4201	Sleep quality ($p < .001$) Low stress: 50.2 (poor sleep quality); 73.3 (good sleep quality) Medium stress: 41.9 (poor sleep quality); 24.5 (good sleep quality) High stress: 7.7 (poor sleep quality); 1.5 (good sleep quality) Sleep duration ($p < .001$) Low stress: 74.8 (poor sleep duration); 67.0 (good sleep duration) Medium stress: 23.4 (poor sleep duration); 29.7 (good sleep duration) High stress: 1.3 (poor sleep duration); 2.5 (good sleep duration)

Use of bed for activities other than sleep or sex - *no articles found*

Uncomfortable bed/bedding - *no articles found*

Sleep environment (e.g., light, heat)

Burgess et al.	2018	United States	Single-arm trial	Bright light exposure for 13 days following 7 days baseline in individuals with chronic low back pain. N = 37	Total sleep time Pre-intervention: 402.47 (±75.66) mins Post-intervention: 383.40 (±67.46) mins Bedtime* (p>.05) Pre-intervention: 23:25 (±1.80) Post-intervention: 22:55 (±1.75) Dim light melatonin onset (DLMO)* Pre-intervention: 19:58 (±1.57) Post-intervention: 19:11 (±1.46)
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Pre-bed work - *no articles found*

Pre-bed routine - *no articles found*

Note. SHAPS – Sleep Hygiene Awareness and Practice Scale; PSAS – Pre-Sleep Arousal Scale; PSQI – Pittsburgh Sleep Quality Index; MDD – Major Depressive Disorder; ASHS – Adolescent Sleep Hygiene Scale; VAS – Visual Analogue Scale; SPI II – Sleep Problem Index II; ISI – Insomnia Severity Index; PROMIS – Patient Reported Outcomes Measurement Information System; DLMO – Dim Light Melatonin Onset.

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For peer review only

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	n/a
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	10
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	n/a
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	n/a

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	10
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Supplementary table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	14
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
 * Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
 † A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
 ‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
 § The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.

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Title: Are current sleep hygiene strategies effective for individuals with chronic pain? A scoping review

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Running Title: Pain and sleep hygiene

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ABSTRACT

Objectives: Up to a quarter of the world’s population experience chronic pain, which, in addition to interfering with daily activities and waking function, is often associated with poor sleep. Individuals experiencing poor sleep are often encouraged to implement sleep hygiene strategies. However, current sleep hygiene strategies have not been developed considering the unique challenges faced by individuals with chronic pain and therefore they might not be as effective in this population. The aim of this scoping review is to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain.

Design: This scoping review included a search of four online databases (Medline, Embase, PSYCInfo, and CINAHL) to identify articles examining the use and effectiveness of sleep hygiene strategies in populations with chronic pain.

Results: Thirty articles investigated at least one sleep hygiene strategy in individuals with chronic pain, with evidence found to support the use of six sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment). However, the timing of these strategies was often not reported, which limits the degree to which these strategies can be generalised for use as a pre-sleep strategy.

Conclusion: While sleep hygiene strategies may be used by people living with chronic pain and are often recommended by professional bodies for this population, there are limitations of the existing literature that supports the effectiveness of all strategies. The efficacy of sleep hygiene practices in different chronic pain sub-populations should be the focus of future research in order to develop tailored strategies for individuals with chronic pain.

Strengths and limitations of this study

- This is the first scoping review to explore sleep hygiene strategies in chronic pain populations
- A strength of this scoping review was the comprehensive search strategy and broad inclusion criteria.
- As this was a systematic review, , studies of lower quality may be included.
- The terminology used to discuss sleep hygiene varied greatly amongst the included studies which may have resulted in studies missed.

KEYWORDS

Pain management, Sleep Medicine, Back pain

INTRODUCTION

Chronic pain is pain existing or reoccurring for longer than three months and is multifactorial, having social, biological, and psychological attributes [1, 2]. Globally, chronic pain is the leading cause of disability and disease burden [3], affecting between one-third and one-half of the population in the United Kingdom, United States and Australia [4]. In addition to the economic burden of chronic pain, there can be a significant personal cost. Difficulty in mobilisation, an increased likelihood of depression, a reduction in quality of life, and an increased need for healthcare are all common experiences for individuals experiencing chronic pain [5]. Another common issue for those experiencing chronic pain is poor sleep, that is, disturbed sleep quality and quantity [5].

The relationship between poor sleep and chronic pain is well documented [5-7] and bi-directional [8, 9]. Individuals with chronic pain generally report poorer sleep quality [10,

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11] and quantity [10-12] compared to those without chronic pain. This is problematic, as sleep is a biological need, with 7-9 hours of sleep per night recommended for adults for optimal health and wellbeing [13, 14]. Poor sleep is associated with poorer physical and psychological health outcomes [15, 16], in addition to impaired cognition, memory, attention, and alertness [5, 17, 18]. Conversely, adequate night-time sleep appears to be predictive of less pain and may assist individuals to cope with chronic pain [5, 7]. Thus, there are likely to be far reaching benefits of improving sleep in individuals experiencing chronic pain.

There is a need for strategies to improve sleep to be incorporated into current treatment and management approaches for chronic pain. While there are various strategies to manage chronic pain [19], historically, medication is the most common treatment for pain symptoms [20-22]. However, some pain medications can impact sleep [23-25] and people with chronic pain have a higher risk of substance abuse [26]. Evidence is growing to support a multidisciplinary approach to pain management using a biopsychosocial framework [26]. Consequently, other strategies are being utilised to manage sleep and pain, including behavioural, non-pharmacological strategies [26, 27]. One such behavioural strategy is sleep hygiene.

Sleep hygiene can be described as healthy sleep practices, including lifestyle, environmental and behavioural strategies [28-30]. A set of sleep hygiene guidelines was proposed by Mastin, et al. [31], and promoted by the Australasian Sleep Association and the Sleep Health Foundation [32, 33]. An overview of sleep hygiene strategies is presented in Table 1. Improving sleep hygiene has been shown to improve sleep in a range of populations including students [34, 35], older adults [36-38], athletes [39, 40], and individuals with sleep disorders such as insomnia [41]. However, there are limitations to our current understanding of the effectiveness of sleep hygiene strategies. In particular, there are no current evidence-based guidelines on the use of sleep hygiene strategies in individuals living with chronic pain.

Table 1. *Sleep hygiene strategies (adapted from Mastin et al. 2006)*

Sleep hygiene strategy
Avoid daytime naps lasting two or more hours
Go to bed at the same time each day
Get out of bed at the same time each day
Avoid exercising to the point of sweating within 1h of going to bed
Avoid staying in bed longer than you should two or three times a week
Avoid anything that may alert you before bedtime
Avoid going to bed feeling stressed, angry, upset, or nervous
Avoid using your bed for things other than sleeping or sex
A comfortable bed
A comfortable bedroom (temperature, light, noise)
Avoid important work before bedtime
Avoid thinking, planning, or worrying when in bed

Given the association between chronic pain and poor sleep, and the trend toward behavioural strategies being recommended for sleep improvement, it is critical to understand the effectiveness of sleep hygiene strategies in this population. While guidance on the use of sleep hygiene strategies is readily available for people living with chronic pain as part of free online resources for chronic pain management [42-44], to date, no study has investigated whether the sleep hygiene guidelines are useful for improving sleep in this population.

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This scoping review aims to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain. Scoping reviews are considered an ideal tool to determine the scope of a body of literature [45]. Thus, a scoping review was chosen to allow the research team to explore the literature that currently exists in the area of sleep hygiene strategy use in individuals experiencing chronic pain and identify specific gaps in the literature. This scoping review is the first step in understanding whether sleep hygiene strategies are effective in a chronic pain population.

METHODS

Patient and public involvement: The design of this research was without patient or public involvement, and the conduct of this research was carried out without the involvement of patients (participants).

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis – Scoping Reviews (PRISMA-ScR) guidelines were followed for this review [46]. A search was performed using the databases Medline, Embase, PSYCInfo, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search was conducted on 22nd April 2021. Searches were performed of peer reviewed abstracts within all databases. Search terms included ‘sleep’ and ‘chronic pain’ and a series of terms covering components of sleep hygiene. Search terms used (with slight differences based on database requirements) were:

Sleep AND “chronic pain” AND (“sleep hygiene” OR napping OR
bed time OR wake time OR exercise OR alcohol OR tobacco OR
smoking OR caffeine OR alert* OR activity OR emotion* OR mood
OR sex OR bed OR bedding OR light OR heat OR cold OR
temperature OR noise OR sound OR work OR worry OR rumination
OR stress OR routine)

Search terms were chosen to align with established sleep hygiene strategies. See Table 2 for an overview of strategies and aligned search terms.

Table 2. *Sleep hygiene strategies and aligned search terms*

Sleep hygiene strategy	Search terms
Napping	Napping
Consistent bed and wake time	Bed time OR wake time
Pre-bed exercise	Exercise
Alcohol	Alcohol
Tobacco	Tobacco OR smoking
Caffeine	Caffeine
Pre-bed alerting activities (e.g., video games, internet)	Sleep hygiene OR alert* OR activity
Pre-bed state (e.g., stress, anger, worry, rumination)	Emotion* OR mood OR worry OR rumination OR stress
Use of bed for activities other than sleep or sex	Activity OR sex
Uncomfortable bed/bedding	Bed OR bedding
Sleep environment (e.g., light, heat)	Light OR heat OR cold OR temperature OR noise OR sound
Pre-bed work	Work
Pre-bed routine	Routine

Reference lists were also hand-searched to identify any additional articles that were not included in the initial search.

Eligibility criteria

The PICO structure was used to develop the key inclusion criteria for this review (Population, Intervention, Comparison, Outcome) (Higgins et al., 2021). See Table 3 for the PICO strategy.

Table 3. *Cochrane PICO strategy*

Population	Intervention	Comparison	Outcome
Chronic pain population of any kind	Sleep hygiene intervention (refer to Table 1)	No comparison required. Typically, a control group where no intervention is used.	A minimum of one sleep outcome (subjective and/or objective measures)

To be included in this literature review, articles were required to be published in a peer reviewed journal (i.e., no industry reports or grey literature were included). No limits on the year of publication were included. Case studies and reviews were excluded, as were studies that were not written in English. Articles were required to include at least one sleep hygiene strategy. with a population experiencing chronic pain of any kind, and a minimum of one subjective or objective measure of sleep was required. (For the purposes of this review, any sleep hygiene strategy used in an included study is termed a sleep hygiene intervention).

Data charting

Data extracted from the included articles included year of publication, authorship team, location, study design, population, and study setting. Additionally, the aspect(s) of sleep

hygiene that each article addressed was identified (e.g., caffeine use, pre-bed routines).

Results were then synthesised by sleep hygiene strategy.

RESULTS

Selection of sources of evidence

Searches identified a total of 946 peer reviewed journal articles (after duplicate removal) that were screened based on title and abstract. Full text review was performed of 88 journal articles, of which 30 met the criteria for inclusion. See Figure 1 for an overview of screening procedures (PRISMA flowchart). Full text screening was performed by authors MS and SF. Any discrepancies were resolved by consulting with a third author (CG).

INSERT FIGURE 1

Characteristics of sources of evidence

Study design, location, year of publication, population, study setting, and outcomes are presented in Supplementary File 1. The following strategies had associated articles: alcohol use (n = 2), exercise (n = 10), light (n = 1), pre-bed state (n = 11), tobacco use (n = 3), and sleep hygiene education (n = 1). An additional two papers included both measures of sleep hygiene and sleep in a chronic pain population. No studies were found addressing any other sleep hygiene strategies in a chronic pain population.

Chronic pain populations included individuals with fibromyalgia (n = 3), non-specified chronic pain (n = 6), non-cancer related chronic pain of any kind (n = 4), chronic spinal pain (n = 1), chronic benign neck, low back and/or generalised pain (n = 2), chronic low back pain (n = 2), musculoskeletal chronic pain (n = 3), back pain, osteoarthritis, and/or rheumatoid arthritis (n = 1), Failed Back Surgery Syndrome (n = 1), chronic knee pain (n = 1), sickle cell

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disease (n = 1), orofacial pain (n = 1), chronic rheumatic conditions (n = 2), cancer (n = 1), and Parkinson’s disease (n = 1). Participants in the included studies included adults (n = 29) with one study including child participants (n = 1).

Synthesis of results

Each sleep hygiene strategy for which studies were identified is discussed. The strategies are listed based on most evidence from the literature to least evidence.

Pre-bed state

Eleven studies examined pre-bed state and sleep outcomes in patients with chronic pain [47-57]. There was methodological heterogeneity amongst these 11 studies. Of the studies that utilised a cross-sectional design, two investigated the impact of pre-sleep arousal on scores on the Insomnia Severity Index in participants with chronic pain [49, 51]. Both studies demonstrated that higher scores on the Insomnia Severity Index, indicating impaired sleep, were associated with greater pre-sleep arousal. The study by Zaidel, et al. [57] used a cross-sectional design in older adults (>65 years old) diagnosed with chronic pain and reported that higher daily stress was associated with poor sleep quality and quantity. Daily stress was also associated with poor sleep quality in a sample of children diagnosed with sickle cell disease [56].

Mindfulness and meditation were also common amongst the studies that addressed pre-bed state and sleep [47, 52, 53, 55]. Mindfulness programs were assessed in populations of patients with chronic non-cancer pain [47], failed back surgery syndrome [52], chronic knee pain [53], and chronic low back pain [55]. There were mixed findings, with some studies identifying less sleep disturbance post-mindfulness intervention [47, 55], and the remaining

two studies showing no benefit of mindfulness on sleep compared to a control condition [52] or listening to music [53].

Relaxation was also investigated as a pre-bed state strategy [48, 50, 54]. Findings were again mixed with improvements in subjective sleep quality seen after using progressive relaxation in a sample of 19 participants with chronic pain [50] and in a sample of 36 participants with chronic back or joint pain [54]. Conversely, no improvement in sleep quality was seen in a sample of 12 participants with musculoskeletal pain who completed a pre-bed relaxation intervention [48].

Exercise

Ten studies assessed exercise as a sleep hygiene strategy, with mixed findings. Decreases in insomnia severity [58, 59], decreases in sleep problems [60], and increases in sleep quality [61, 62] were found after some exercise interventions to increase activity during the day in participants living with chronic pain. Other studies however, found that higher daytime activity was associated with either no change in insomnia symptoms [63], poorer sleep quantity and quality in individuals with chronic pain [64-66].

Tobacco

Three studies investigated tobacco use and sleep outcomes in patients with chronic pain [67-69]. Cross-sectional study designs were used in all three studies, with both Burris, et al. [68] and Khan, et al. [67] doing retrospective reviews of clinical care data from patients experiencing chronic pain. In both studies sleep disturbance was significantly worse in participants that smoked compared to those that didn't, as measured by the PSQI [68] and a sleep-related question from the Patient-Reported Outcome Measurement information System [67]. Similar results were seen in the study conducted by Stipelman, et al. [69], with data from a National Health Interview Survey. Smokers were more likely to have short sleep

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duration (<6h) compared to non-smokers in a sample of 22, 850 patients with chronic rheumatic conditions.

Sleep hygiene

Two studies measured the relationship between the use of ‘sleep hygiene practices’ as a whole and sleep outcomes in individuals with chronic pain [70, 71]. Emery, et al. [71] conducted a study in which 60 participants completed a survey including the Sleep Hygiene Awareness and Practice Scale and the Pittsburgh Sleep Quality Index (PSQI). They found that participants with musculoskeletal chronic pain reported better sleep hygiene than those with comorbid major depressive disorder and musculoskeletal pain. However regardless of sleep hygiene use, all participants had poor sleep onset latency and sleep quality. Likewise, in a study of adolescents with and without chronic pain [70], those with chronic pain had poorer sleep quality despite a similar use of sleep hygiene amongst participants.

Alcohol

Alcohol use and sleep was investigated in samples of patients with chronic pain in two studies [72, 73]. Graham and Streitel [72] had 108 college students with any reported type of chronic pain complete a survey about alcohol use and sleep and found that increased alcohol use was associated with poorer sleep. Similarly, Miller, et al. [73] found that an increase in alcohol consumption resulted in increased sleep latency in a sample of 23 students with fibromyalgia who completed 14-day alcohol and sleep diaries.

Education

One study was identified that investigated the influence of education about healthy sleep as a sleep hygiene strategy [74]. Berry et al. (2015) conducted a randomised controlled trial with 85 participants with chronic non-cancer pain and found that a four-week sleep hygiene education program improved sleep onset latency in people living with chronic pain compared

to a control group of people living with chronic pain who did not receive the same education program.

Sleep environment

Only one study identified in this review investigated optimising the sleep environment [75]. Morning bright light was used in 37 participants with chronic back pain for 13 days. It was found that subjective sleep quality improved post-bright light treatment, compared to pre-treatment.

No evidence found

No studies included in this review presented information on napping, consistent bed and wake times, caffeine use, pre-bed activities (not mood related), bed and bedroom use, uncomfortable bed/bedding, pre-bed work, or pre-bed routines.

Discussion

The aim of this scoping review was to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain.. While there was a range of literature supporting the use of sleep hygiene strategies in individuals with chronic pain, the heterogeneity of sleep hygiene strategies used, and chronic pain samples studied limits the generalisability of current findings. . This finding is important to consider given that sleep hygiene strategies are commonly recommended for those with chronic pain as part of behavioural treatments [76].

Studies were found that supported the use of six specific sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment), the most promising of which appear to be management of pre-bed state and use of daytime exercise. Standard sleep hygiene advice relating to pre-bed state highlights the

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need to avoid thinking, planning and worrying before sleep [31]. The 11 identified studies that addressed pre-bed state suggest that using strategies such as relaxation [48, 50], mindfulness [47, 52], and meditation and music [53] can improve sleep quality and decrease sleep disturbance in people with chronic pain. However, it must be noted that many of the included studies did not require these relaxation strategies to be performed immediately prior to bed (i.e., these activities were performed at any time of day). It is possible that the impact of these activities on pre-bed state (and potentially on subsequent sleep) would be greater if performed within the context of a specific sleep hygiene intervention (i.e., if relaxation or mindfulness activities were performed in the hour or two before bed). The studies for pre-bed state as a sleep hygiene strategy included participants from a wide range of age groups. This is an important consideration when interpreting the impact of this sleep hygiene strategy, as there are age-related changes in sleep across the lifespan [77], which may mean that the sleep of different age groups are differentially impacted by sleep hygiene strategies. Further, given that chronic pain is typically associated with high levels of stress and anxiety [78], it is likely that interventions designed to improve pre-bed state may be of particular importance for improving sleep in this population [79].

Conflicting results were found for exercise as a sleep hygiene strategy in people with chronic pain. Given that there was a high level of heterogeneity in the types and duration of exercise measured in each study, no one study can provide recommendations for the optimal type or duration of exercise for improving sleep in individuals with chronic pain. It is also likely that the effectiveness of exercise as a strategy for improving sleep differs based on the type of chronic pain experienced by the individual, as well as the type of exercise (e.g. high intensity vs low intensity). This corresponds to previous literature showing that overactivity can exacerbate symptoms of chronic pain [64]. Further, it is important to note that while the sleep hygiene guidelines by Mastin, et al. [31] recommend avoiding exercise within one hour

of going to bed, a recent systematic review and meta-analysis of 23 articles found that overall, evening exercise did not influence sleep quality [80]. Given that the exact timing of exercise was not investigated in the studies identified in the present review, it is unknown if there is an optimal time of day to exercise for people living with chronic pain in relation to sleep outcomes. As such, there is a need for future research to address both the timing, type and duration of exercise used by individuals with different types of chronic pain when considering the impact on subsequent sleep. This research will inform targeted recommendations for exercise as a sleep hygiene strategy for individuals with chronic pain.

Alcohol and tobacco intake was also investigated in the reviewed studies, with sleep disturbances in individuals with chronic pain associated with increased tobacco use and alcohol use [67-69, 72, 73]. Of note however, is that the sleep hygiene recommendation is to avoid these substances in the four hours prior to bed [31]. In the studies included in this review, however, overall daytime consumption of alcohol or tobacco was measured rather than specific timing of consumption (i.e., whether alcohol/tobacco were consumed close to bedtime). Therefore, timing of alcohol and tobacco use, rather than restriction of alcohol use, is the critical question in the context of a sleep hygiene strategy and should be considered within future research. This research is particularly important given that alcohol may negatively interact with pain medications [72], and tobacco can contribute to higher pain intensity [81]. Furthermore, alcohol has reportedly been used to self-medicate in some individuals with chronic pain [82], and there may therefore be reluctance to decrease or stop use in the absence of a pain management alternative.

Despite identifying existing literature that supports the use of certain sleep hygiene strategies in individuals with chronic pain, caution must be taken when recommending these strategies due to the limited scope of the literature. Firstly, there are diagnosis-specific characteristics found in different chronic pain conditions [83]. For example, people with

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nociplastic conditions such as fibromyalgia or complex regional pain syndrome are known to have higher sensory sensitivity, and suffer from fatigue and insomnia more than people with other pain conditions [26]. This is likely to influence the efficacy of sleep hygiene strategies for this specific chronic pain population. Further, it is likely that were these sleep hygiene strategies to be recommended, some modifications may be necessary to tailor the recommendations for individuals with chronic pain. For example, one sleep hygiene strategy involves avoiding alerting activities before bedtime, such as the use of a mobile phone, internet, or video games. However, such tasks have been shown to be a distraction from pain symptoms [84, 85]. Therefore, a suggestion to avoid these tasks before bed may increase awareness of pain symptoms before bed which would have a negative impact on sleep. A pre-bed activity that is distracting from pain but not alerting may be an appropriate alternative for individuals with chronic pain. Modifications such as this should be considered for all sleep hygiene strategies.

No studies investigated the use of the remaining eight sleep hygiene strategies (pre-bed work; pre-bed routine; use of bed for activities other than sleep or sex; uncomfortable bed or bedding; caffeine; pre-bed alerting activities; napping; and consistent bed/wake times). A priority for future research is to investigate the efficacy of these strategies for improving sleep in chronic pain populations. An important first step could be to investigate the caffeine-related strategy, as caffeine is known to play a role in pain management due to the adjuvant analgesic effects[86, 87]. Much like alcohol and tobacco, caffeine is best avoided in the four hours prior to bed according to the general sleep hygiene guidelines [31]. However, no studies assessing this strategy in a chronic pain population were identified in this review. Further, several studies have highlighted that those with chronic pain consumed significantly more coffee than those without chronic pain [88-90]. This highlights the need for further

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3 investigation of the relationship between caffeine use, chronic pain, and sleep, given the high
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5 amount of use of caffeine in a chronic pain population.
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8 The limitations of this review must be acknowledged. This is a scoping review,
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10 designed to overcome the evidence bias that may be present in a narrative review but with a
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12 broader search than a systematic review in order to understand a wider research area [45]. A
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14 full systematic strategy that involves assessing risk of bias was not conducted given the
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16 heterogeneity of the literature. It is therefore possible that studies of lower quality (than
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18 would otherwise be included in a systematic review) were included. Additionally, a limitation
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20 of the search strategy is that terminology used to discuss sleep hygiene throughout the
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22 literature was not consistent and many studies did not use the term sleep hygiene. While the
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24 search strategy was widened to include terms relating to specific strategies, it is possible that
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26 some articles were missed.
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32 The review highlights that while sleep hygiene is promoted as a non-pharmacological
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34 strategy for improving the sleep of those with chronic pain, there is a limited research on the
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36 efficacy of these strategies in individuals with chronic pain. While creating, evaluating, and
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38 promoting targeted sleep hygiene guidelines for people living with chronic pain is a goal,
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40 more research is needed. Firstly, assessment of the efficacy of current sleep hygiene
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42 strategies in individuals with chronic pain is required. Specifically, certain activities (e.g.,
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44 exercise) would ideally be investigated in the context of the pre-bed period, taking account of
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46 timing. While research on some sleep hygiene strategies was identified, only tentative support
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48 could be provided due to the heterogeneity of type and duration of sleep hygiene strategies
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50 used. Therefore, studies should be designed to evaluate the efficacy of certain sleep hygiene
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52 strategies in individuals with chronic pain. The differences between chronic pain conditions
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54 must also be considered, in addition to individuals experiencing chronic pain as a symptom of
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56 a treatment (e.g. chronic pain associated with chemotherapy ⁷¹). Finally, qualitative
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approaches will be critical in understanding the lived experience of chronic pain and the use of sleep hygiene strategies.

This scoping review mapped the current literature addressing sleep hygiene in individuals experiencing chronic pain. Limited literature was identified, and while some strategies show promise for improving sleep in people living with chronic pain, the timing of the strategy use/implementation was not examined. Given the relationship between sleep quality and pain, as well as the fact that sleep hygiene is commonly promoted to people with chronic pain, future research into the efficacy of sleep hygiene programs is needed. This is necessary to ensure that advice given to people living with chronic pain is evidence-based and will lead to improvements in sleep.

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Figure 1. Screening Process

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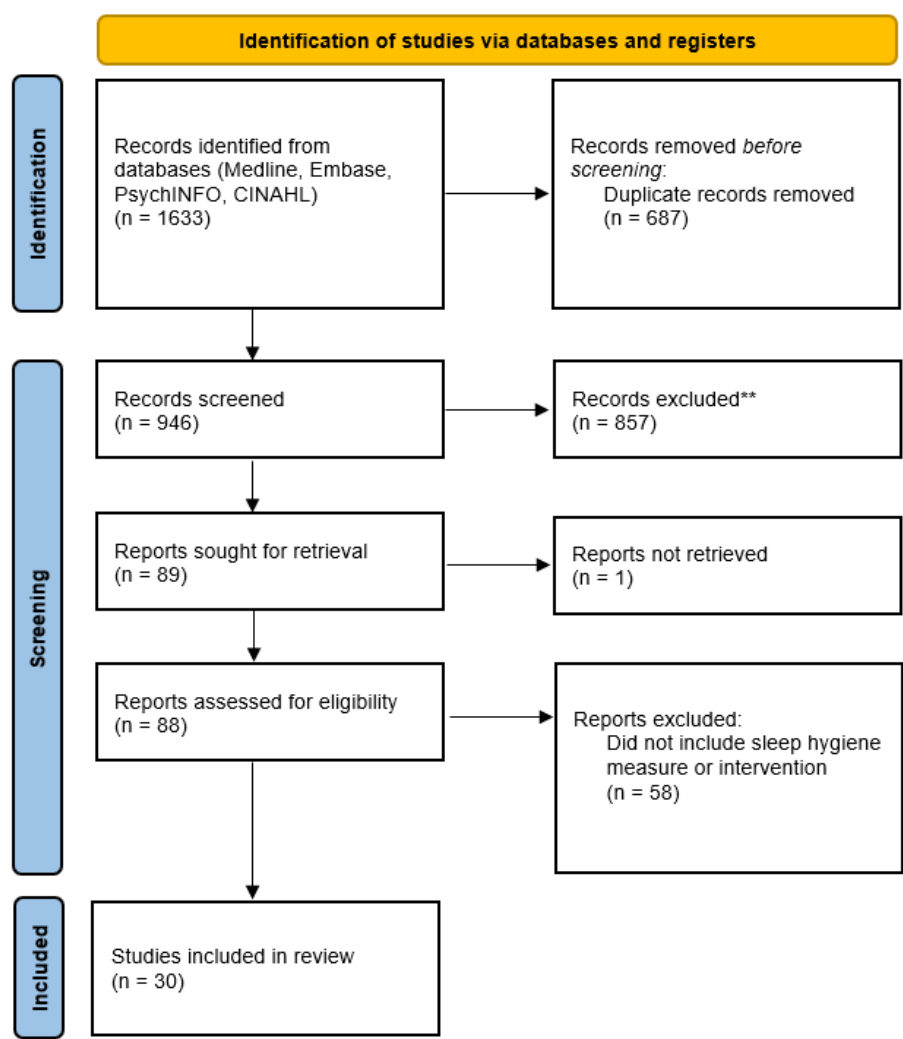


Figure 1. Screening process

Supplemental File 1. Data Charting Table

Author	Year	Location	Study design	Sample size and age (M±SD)	Sleep measure	Sleep hygiene-related intervention	Findings
Sleep hygiene strategy	All sleep hygiene strategies						
	Emery et al.	2014	Canada	Multi-component study including qualitative interviews, cross-sectional survey, and observational data	60 (44 female) adults with and without major depressive disorder. Age 46.0±9.2 years.	Cross-sectional component of study included the completion of the SHAPS, PSAS, and the PSQI. Participants also completed daily sleep diaries.	Reporting on sleep hygiene practices
							PSQI (p>0.10) MDD group: 15.48(±3.68) Non-MDD group: 14.84(±4.06)
							SHAPS (p=0.06) MDD group: 35.61(±15.30) Non-MDD group: 28.31(±13.80)
							PSAS – somatic (p=0.070) MDD group: 16.38(±5.12) Non-MDD group: 14.12(±4.27)
							PSAS – cognitive (p=0.009) MDD group: 21.11(±7.66)

								Non-MDD group: 16.44(±5.30)
Walker et al.	2010	United States	Cross-sectional observational design	51 adolescents (22 female) receiving chemotherapy treatment for cancer. Aged 14.2±2.7 years.	ASHS, 7-day sleep diary	Outcomes compared on the Adolescent Sleep Hygiene Scale		Sleep environment subscale (p≤.001) Cancer group: 5.0(±0.9) Healthy controls: 5.5(±0.6)
				Compared to a sample of 20 healthy norms.				Sleep stability subscale (p≤.001) Cancer group: 3.7(±1.1) Healthy controls: 4.3(±0.7)
								ASHS total score (p≤.001) Cancer group: 4.7(±0.5) Healthy controls: 5.0(±0.4)
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Berry et al.	2015	Canada	Sleep education Between-subject randomised controlled trial	85 (52 female) patients with non-cancer pain randomly allocated	Intervention group with one-on-one didactic	Intervention consisted of one-on-one didactic sleep		Sleep latency (week 4)* (p < .02)
<hr/>								

to a treatment group ($n=44$, aged 50.4 ± 10.4 years) or a control group ($n=41$, aged 48.5 ± 11 years). session including practical steps for improving sleep, control group. hygiene sessions with practical steps for improving sleep. Sleep hygiene group: 93.9 (± 42.6) mins Control group: 118.4 (± 45.1)

Sleep quality (week 4)
Sleep hygiene group: 2.8 (± 0.8)
Control group: 2.9 (± 0.7)

Time in bed (week 4)
Sleep hygiene group: 7.5 (± 1.6)
Control group: 7.2 (± 1.1)

Napping - *no articles found*

Consistent bed and wake time - *no articles found*

	Exercise						
Andrews et al.	2014	Australia	Observational, prospective, within-person study design	50 (30 female) patients with non-cancer related chronic pain. Aged 54.2 ± 10.7 years.	Activity monitor and questionnaire completion over five days	Comparison of daily physical activity and sleep outcomes	Higher daytime activity associated with greater overnight wakefulness

							(β =.29, $t_{88.84}=2.09$, $P=.04$, 95% CI=0.0015 to 0.06)
Asih et al.	2014	United States	Prospective within-subject study design	262 (87 female) patients with chronic disabling occupational musculoskeletal disorders. Aged 44.9±10.9 years.	ISI	Quantitatively directed exercise progression program including approximately 4-6h activity per day over 4-8 weeks.	53.4% of participants moved to a lower category on the Insomnia Severity Index at the end of treatment.
Evans et al.	2013	United States	Exploratory randomised usual-care waitlist-control design	26 female patients with rheumatoid arthritis, aged 28.3±3.9 years.	Weekly rating of trouble with sleeping	Participation in yoga program. Data collected at three timepoints (baseline, post-treatment, 2 month follow up)	No significant differences in sleep outcomes for participants in the yoga group ($p = .100$)
Hall et al.	2019	United States	Prospective baseline, pre- and post- intervention design	33 (25 female) patients at a pain management clinic, aged 51.4± 11.3 years.	SPI II completed baseline, pre- and post-intervention	Participation in a 10-week yoga program. . One third of participants (N = 11) completed pre-	SPI II Baseline (N = 33): 50.9 ± 21.3 Pre-intervention (N = 27): 49.4 ± 20.5

						and post-intervention measures.	Post-intervention (N = 11): 37.9 ± 23.1
Jones et al.	2012	United States	Parallel-group randomised controlled trial	98 (91 female) individuals diagnosed with fibromyalgia. Average age 54 years (no SD provided, range 40.7-74.1 years).	PSQI	8-form Yang-style Tai chi program compared to an education control	PSQI global score Tai chi group: -2.0 points Control group: 0.03 points
McGovney et al.	2020	United States	Observational, prospective, within-person study design	160 (150 female) participants diagnosed with fibromyalgia who reported insomnia complaints. Aged 52.4±11.7 years)	Actigraphy	14-day data collection of usual physical activity	Reduced total sleep time, sleep latency, wake after sleep onset, and sleep efficiency after afternoon activity, (p < .001 for all variables), and early evening activity (p < .001 for all variables)
Nguy et al.	2020	Australia	Observational cross-sectional design	52 (16 female) participants with Parkinson's disease, aged 67.8±7.8 years.	PSQI and actigraphy	7-day data collection of usual physical activity, sleep, and pain	Increased physical activity associated with increased pain (p<.05) Poor sleep associated with

							increased pain ($p<.05$)
Skarpsno et al.	2018	Norway	Longitudinal design	21, 847 participants (11,909 female) with and without chronic pain. Age of chronic pain group ($n=5305$) 47.6 ± 12.0 , age of no chronic pain group ($n=6605$) 47.6 ± 12.0 (overall sample mean not provided)	Questions on insomnia symptoms	Historical data of a sample of the general population including measures of chronic pain, physical activity, and insomnia at baseline (1955-97) and followed up in 2006-08.	No combined effect of physical inactivity and ≥ 5 pain sites on risk of insomnia (RERI: 0.88 (95% CI: $_{-0.85, 2.60}$)) With 1-4 pain sites, physical activity resulted in a lower risk of insomnia ($p<0.05$).
Tang et al.	2014	United Kingdom	Observational cross-sectional design	119 (88 female) patients with chronic pain and insomnia, aged 46.0 ± 10.9 .	Sleep diary and actigraphy	7-day data collection of usual sleep and physical activity	Sleep quality predicted physical activity ($p= .017$)
Wiklund et al.	2018	Sweden	Randomised controlled trial	185 (participant sex not reported) patients with chronic benign neck, low back, and/or generalized pain, aged 54.2 ± 10.2 years.	ISI	Participants randomly allocated to complete 7-8 weeks of treatment (exercise or stress management) or control).	Post-intervention ISI *= significantly different from baseline measurement ($p<.05$) Exercise group: $11.19 \pm 6.27^*$ Stress management

group: $12.22 \pm 6.38^*$
Control group:
 12.59 ± 7.13

		Alcohol use						
	Graham & Streitel	2010	United States	Cross sectional design	362 (265 females) participants, aged 20.6 ± 1.6 years, with chronic pain ($n=108$) and without chronic pain ($n=254$).	PSQI	Participants completed a survey on usual experience of chronic pain, and usual sleep quality and alcohol use	Alcohol use predicted poor sleep quality $b = .29$, $p < .01$
	Miller et al.	2018	United States	Observational, prospective, within-person study design	73 adults (68 women) reporting symptoms of chronic pain and insomnia related to fibromyalgia, aged 51.3 ± 12.0 years.	Sleep diary	14-day data collection of usual alcohol use and sleep patterns	Each alcoholic drink consumed resulted in an increased sleep latency of 5.0 minutes.
		Tobacco use						
	Burris et al.	2013	United States	Cross-sectional design	48 (all female) patients experiencing orofacial pain, aged 41.1 ± 13.3 years.	PSQI	Retrospective chart review of new-patient questionnaires on sleep quality, and smoking behaviour.	PSQI global score* ($p > .05$) Non-smokers: 1.44 (1.08) Smokers: 2.00 (0.93)

Khan et al.	2019	United States	Longitudinal design	8584 patients attending the Stanford Pain Management Center from 2013-2017. Participants split into smokers ($n=727$) aged 47.9 ± 12.9 years, and non-smokers ($n=5254$) aged 49.4 ± 16.5 years (overall sample age not provided).	PROMIS	Participants completed PROMIS (with sleep and smoking-related questions) at two time points: baseline, and time 2 (6-8 weeks following baseline) after they have received a range of recommendations for pain management.	Sleep disturbances significantly worse in smokers than non-smokers at baseline and time 2: $p < .001$
Stipelman et al.	2013	United States	Cross-sectional design	22,850 (11,640 females) participants from the National Interview Survey. Aged 18+ (mean age not provided) Participants were split into 2 groups, those with a chronic rheumatic condition causing pain ($n=1417$ females)	Questions on sleep duration from the National Health Interview Survey	Questions from the National Health Interview Survey on usual smoking behaviour.	Reported <6h sleep/night Smokers: 25.4 % Non-smokers: 15.2%

and those without a
chronic rheumatic
condition (n=11, 224
females)

Caffeine - *no articles found*

Pre-bed alerting activities (e.g., video games, internet) - *no articles found*

Pre-bed state (e.g., stress, anger, worry, rumination)

Brintz et al.	2020	United States	Mixed-methods, single-group, pre-post design	23 adults (17 female) experiencing non-cancer chronic pain, Mean age 53 years (no SD provided).	PSQI and actigraphy	Participants completed four weekly sessions of mindfulness-based stress reduction	Sleep disturbance* (p>.05) Pre-intervention: 56.52 (±7.79) Post-intervention: 51.83 (±9.75)
Brown et al.	2014	Canada	Case series study	12 patients (9 women) with a diagnosed musculoskeletal condition and self-reported problems with sleep, aged 58.4±9.5 years.	PSQI and actigraphy	Participants completed 7-days of baseline data collection, were taught a hand self-Shiatsu method, and completed two follow ups (2 and 8 weeks)	No significant differences in PSQI or actigraphy outcomes from baseline to follow up (no figures reported).
Byers et al.	2016	United States	Cross-sectional design	48 adults (36 female) with chronic pain,	ISI	Participants completed a	13% of variance in scores on ISI

				aged 51.6±11.9 years.		questionnaire on pain, cognition, and sleep.	explained by cognitive and somatic scores on the PSAS (p=.001)
Chen & Francis	2010	Australia	Randomised controlled trial	19 participants (13 female) with current chronic pain, aged 39.3±13.0 years).	VAS relating to sleep quality	Participants completed 1 week of baseline data collection followed by 6 weeks of either treatment (abbreviated progressive relaxation technique and guided imagery intervention) or control.	Sleep quality VAS ratings Intervention group: 75% of participants saw improvement Control group: 28.57% of participants saw improvement
Dillon et al.	2012	United States	Cross-sectional	48 adult (36 female) outpatients with chronic pain, aged 51.6±11.9 years.	ISI	Inter-group comparison of cognitive and somatic pre-sleep arousal, based on Insomnia Severity Index (ISI) scores.	PSAS item “worry about falling asleep”* (p<.05) Participants with moderate – severe ratings on ISI: 3.2(±1.6)

							Participants with mild ratings on ISI: 2.3(±1.2)
Esmer et al.	2010	United States	A single-center, prospective, randomized, singleblind, parallel-group clinical trial	25 (11 women) patients with persistent leg pain, back pain, or both. Participants assigned to intervention ($n=15$, aged 55.2 ± 11.2 years) or control ($n=10$, aged 54.9 ± 9.5 years). Overall mean age not provided.	PSQI	Participants allocated at baseline to receive mindfulness-based stress reduction therapy or a control for 8-weeks.	Abridged PSQI Intervention group: 2.4 (±0.8) Control group: 2.3 (±0.9)
Innes et al.	2018	United States	Randomised controlled trial	22 (15 female) adults with symptomatic knee osteoarthritis pain, aged 58.5 ± 1.4 years.	PSQI	Participants randomised to a mantra meditation or a music listening program for 8 weeks.	PSQI global score ($p = .23$) Meditation group: 9.78 (±3.24) Music listening group: 8.09 (±2.21)
Linton et al.	1985		Three group pre- and post-test design	28 (15 female) participants with current pain in back or joints. Participants were randomly allocated to a waiting list control ($n=10$, age mean	Questions on sleep latency, quality, and number of awakenings which were combined	Comparison of waitlist control, regular treatment, and behavioural treatment (including applied	Significantly greater improvements seen in the behavioural treatment group compared with waitlist control

					39.2 years, no SD provided), regular treatment (<i>n</i> =10, age mean 37.6 years, no SD provided), or behavioural training and regular treatment (<i>n</i> =8, age mean 43.1 years, no SD provided)	into one overall sleep outcome metric.	relaxation) groups ,	(<i>p</i> =.020) and regular treatment (<i>p</i> =.049).
	Morone et al.	2008	United States	Qualitative design	27 adults (14 female) with chronic lower back pain, aged 74.3±5.3 years.	Diary with qualitative data on sleep	8-week mindfulness meditation program.	Main themes: <ul style="list-style-type: none">• Pain reduction Improvement in attention skills <ul style="list-style-type: none">• Improved sleep• Wellbeing• Barriers to meditation• Processes of meditation
	Valrie et al.	2007	United States	Prospective observational study	20 children (13 female) with sickle cell disease, mean age 10.1±10.1 years.	VAS relating to sleep quality and sleep duration	Daily diary study in children with sickle cell disease.	Greater stress during the day associated with shorter sleep periods ($\beta = -0.13, p = .04$)
	Zaidel et al.	2021	United States	Cross-sectional design	4,201 (2,827 females) adults with	PSQI	Participants completed a	Sleep quality (<i>p</i> <.001)

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diagnosed back pain,
osteoarthritis, and/or
rheumatoid arthritis,
aged over 65 years
(no mean or SD
provided).

survey on
sleep and daily
stress.

Low stress: 50.2
(poor sleep
quality); 73.3
(good sleep
quality)
Medium stress:
41.9 (poor sleep
quality); 24.5
(good sleep
quality)
High stress: 7.7
(poor sleep
quality); 1.5
(good sleep
quality)

Sleep duration
($p < .001$)
Low stress: 74.8
(poor sleep
duration); 67.0
(good sleep
duration)
Medium stress:
23.4 (poor sleep
duration); 29.7
(good sleep
duration)
High stress: 1.3
(poor sleep
duration); 2.5

								(good sleep duration)
Use of bed for activities other than sleep or sex - <i>no articles found</i>								
Uncomfortable bed/bedding - <i>no articles found</i>								
Sleep environment (e.g., light, heat)								
Burgess et al.	2018	United States	Single-arm trial	37 (10 females) veterans with diagnosed chronic lower back pain, aged 48.4±14.1 years.	PSQI and actigraphy	Participants completed a 7-day baseline followed by 13 days of a 1-hour morning bright light treatment self-administered at home.	Total sleep time Pre-intervention: 402.47 (±75.66) mins Post-intervention: 383.40 (±67.46) mins Bedtime* (p>.05) Pre-intervention: 23:25 (±1.80) Post-intervention: 22:55 (±1.75) Dim light melatonin onset (DLMO)* Pre-intervention: 19:58 (±1.57) Post-intervention: 19:11 (±1.46)	

Pre-bed work - *no articles found*

Pre-bed routine - *no articles found*

Note. M – Mean. SD – Standard Deviation. SHAPS – Sleep Hygiene Awareness and Practice Scale; PSAS – Pre-Sleep Arousal Scale; PSQI – Pittsburgh Sleep Quality Index; MDD – Major Depressive Disorder; ASHS – Adolescent Sleep Hygiene Scale; VAS – Visual Analogue Scale; SPI II – Sleep Problem Index II; ISI – Insomnia Severity Index; PROMIS – Patient Reported Outcomes Measurement Information System; DLMO – Dim Light Melatonin Onset.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	n/a
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	10
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	n/a
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	n/a

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	10
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Supplementary table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	14
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.



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Title: Sleep hygiene strategies for individuals with chronic pain: A scoping review

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ABSTRACT

Objectives: Up to a quarter of the world’s population experience chronic pain, which, in addition to interfering with daily activities and waking function, is often associated with poor sleep. Individuals experiencing poor sleep are often encouraged to implement sleep hygiene strategies. However, current sleep hygiene strategies have not been developed considering the unique challenges faced by individuals with chronic pain and therefore they might not be as effective in this population. The aim of this scoping review is to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain.

Design: This scoping review included a search of four online databases (Medline, Embase, PSYCInfo, and CINAHL) to identify articles examining the use of sleep hygiene strategies in populations with chronic pain.

Results: Thirty articles investigated at least one sleep hygiene strategy in individuals with chronic pain, with improvements to sleep reported for six sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment). However, the timing of these strategies was often not reported which limits the degree to which these strategies can be generalised for use as a pre-sleep strategy.

Conclusion: This scoping review examined the existing literature focussing on sleep hygiene strategies for people with chronic pain. There are limitations to the methodology of the existing literature and gaps in our understanding of sleep hygiene strategies in some chronic pain conditions that must be addressed in future research before the effectiveness of these strategies can be understood.

Strengths and limitations of this study

- This is the first scoping review to explore sleep hygiene strategies in chronic pain populations
- A strength of this scoping review was the comprehensive search strategy and broad inclusion criteria that allowed for an understanding of the current literature.
- As this was a scoping review, to assess the effectiveness of sleep hygiene in chronic pain populations and the quality of the current literature, systematic reviews and meta-analyses are needed as a next step. The terminology used to discuss sleep hygiene varied greatly amongst the included studies which may have resulted in studies missed.

KEYWORDS

Pain management, Sleep Medicine, Back pain

INTRODUCTION

Chronic pain is pain existing or reoccurring for longer than three months and is multifactorial, having social, biological, and psychological attributes [1, 2]. Globally, chronic pain is the leading cause of disability and disease burden [3], affecting between one-third and one-half of the population in the United Kingdom, United States and Australia [4]. In addition to the economic burden of chronic pain, there can be a significant personal cost. Difficulty in mobilisation, an increased likelihood of depression, a reduction in quality of life, and an increased need for healthcare are all common experiences for individuals experiencing chronic pain [5]. Another common issue for those experiencing chronic pain is poor sleep, that is, disturbed sleep quality and quantity [5].

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The relationship between poor sleep and chronic pain is well documented [5-7] and bi-directional [8, 9]. Individuals with chronic pain generally report poorer sleep quality [10, 11] and quantity [10-12] compared to those without chronic pain. This is problematic, as sleep is a biological need, with 7-9 hours of sleep per night recommended for adults for optimal health and wellbeing [13, 14]. Poor sleep is associated with poorer physical and psychological health outcomes [15, 16], in addition to impaired cognition, memory, attention, and alertness [5, 17, 18]. Conversely, adequate night-time sleep appears to be predictive of less pain and may assist individuals to cope with chronic pain [5, 7]. Thus, there are likely to be far reaching benefits of improving sleep in individuals experiencing chronic pain.

There is a need for strategies to improve sleep to be incorporated into current treatment and management approaches for chronic pain. While there are various strategies to manage chronic pain [19], historically, medication is the most common treatment for pain symptoms [20-22]. However, some pain medications can impact sleep [23-25] and people with chronic pain have a higher risk of substance abuse [26]. Evidence is growing to support a multidisciplinary approach to pain management using a biopsychosocial framework [26]. Consequently, other strategies are being utilised to manage sleep and pain, including behavioural, non-pharmacological strategies [26, 27]. One such behavioural strategy is sleep hygiene.

Sleep hygiene can be described as healthy sleep practices, including lifestyle, environmental and behavioural strategies [28-30]. A set of sleep hygiene guidelines was proposed by Mastin, et al. [31], and promoted by the Australasian Sleep Association and the Sleep Health Foundation [32, 33]. An overview of sleep hygiene strategies is presented in Table 1. Improving sleep hygiene has been shown to improve sleep in a range of populations including students [34, 35], older adults [36-38], athletes [39, 40], and individuals with sleep disorders such as insomnia [41]. However, there are limitations to our current understanding

of the effectiveness of sleep hygiene strategies. In particular, there are no current evidence-based guidelines on the use of sleep hygiene strategies in individuals living with chronic pain.

Table 1. Sleep hygiene strategies (adapted from Mastin et al. 2006)

Sleep hygiene strategy
Avoid daytime naps lasting two or more hours
Go to bed at the same time each day
Get out of bed at the same time each day
Avoid exercising to the point of sweating within 1h of going to bed
Avoid staying in bed longer than you should two or three times a week
Avoid anything that may alert you before bedtime
Avoid going to bed feeling stressed, angry, upset, or nervous
Avoid using your bed for things other than sleeping or sex
A comfortable bed
A comfortable bedroom (temperature, light, noise)
Avoid important work before bedtime
Avoid thinking, planning, or worrying when in bed

Given the association between chronic pain and poor sleep, and the trend toward behavioural strategies being recommended for sleep improvement, it is critical to understand the effectiveness of sleep hygiene strategies in this population. While guidance on the use of sleep hygiene strategies is readily available for people living with chronic pain as part of free

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online resources for chronic pain management [42-44], to date, no study has investigated whether the sleep hygiene guidelines are useful for improving sleep in this population.

This scoping review aims to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain. Scoping reviews are considered an ideal tool to determine the scope of a body of literature [45]. Thus, a scoping review was chosen to allow the research team to explore the literature that currently exists in the area of sleep hygiene strategy use in individuals experiencing chronic pain and identify specific gaps in the literature. This scoping review is the first step in understanding whether sleep hygiene strategies are effective in a chronic pain population.

METHODS

Patient and public involvement: The design of this research was without patient or public involvement, and the conduct of this research was carried out without the involvement of patients (participants).

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis – Scoping Reviews (PRISMA-ScR) guidelines were followed for this review [46]. A search was performed using the databases Medline, Embase, PSYCInfo, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search was conducted on 22nd April 2021 by author MS. Searches were performed of peer reviewed abstracts within all databases. Search terms included ‘sleep’ and ‘chronic pain’ and a series of terms covering components of sleep hygiene. Search terms used (with slight differences based on database requirements) were:

Sleep AND “chronic pain” AND (“sleep hygiene” OR napping OR
bed time OR wake time OR exercise OR alcohol OR tobacco OR

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3 smoking OR caffeine OR alert* OR activity OR emotion* OR mood
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5 OR sex OR bed OR bedding OR light OR heat OR cold OR
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7 temperature OR noise OR sound OR work OR worry OR rumination
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10 OR stress OR routine)
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12 Search terms were chosen to align with established sleep hygiene strategies. See Table 2 for
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14 an overview of strategies and aligned search terms.
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Table 2. *Sleep hygiene strategies and aligned search terms*

Sleep Hygiene Strategy	Keyword/term	Search terms
Avoid daytime naps lasting two or more hours	Napping	Napping
Go to bed at the same time each day, get out of bed at the same time each day	Consistent bed and wake time	Bed time OR wake time
Avoid exercising to the point of sweating within 1h of going to bed	Pre-bed exercise	Exercise
Avoid alcohol, tobacco, caffeine within 4h of going to bed or after going to bed	Alcohol; tobacco; caffeine	Alcohol; Tobacco OR smoking; Caffeine;
Avoid anything that may alert you before bedtime	Pre-bed alerting activities (e.g., video games, internet);	Sleep hygiene OR alert* OR activity
Avoid going to bed feeling stressed, angry, upset, or nervous	Pre-bed state (e.g., stress, anger, worry, rumination)	Emotion* OR mood OR worry OR rumination OR stress
Avoid using your bed for things other than sleeping or sex	Use of bed for activities other than sleep or sex	Activity OR sex
A comfortable bed	Uncomfortable bed/bedding	Bed OR bedding
A comfortable bedroom (temperature, light, noise)	Sleep environment (e.g., light, heat)	Light OR heat OR cold OR temperature OR noise OR sound
Avoid important work before bedtime	Pre-bed work	Work
Avoid thinking, planning, or worrying when in bed	Pre-bed routine	Routine

Table 2. Sleep hygiene strategies and aligned search terms

Reference lists were also hand-searched to identify any additional articles that were not included in the initial search.

Eligibility criteria

The PICO structure was used to develop the key inclusion criteria for this review (Population, Intervention, Comparison, Outcome) (Higgins et al., 2021). See Table 3 for the PICO strategy.

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Table 3. *Cochrane PICO strategy*

Population	Intervention	Comparison	Outcome
Chronic pain population of any kind and age	Sleep hygiene intervention (refer to Table 1)	No comparison required. Typically, a control group where no intervention is used.	A minimum of one sleep outcome (subjective and/or objective measures)

To be included in this literature review, articles were required to be published in a peer reviewed journal (i.e., no industry reports or grey literature were included). No limits on the year of publication were included. Case studies and reviews were excluded, as were studies that were not written in English. Articles were required to include at least one sleep hygiene strategy. with a population experiencing chronic pain of any kind, and a minimum of one subjective or objective measure of sleep was required. (For the purposes of this review, any sleep hygiene strategy used in an included study is termed a sleep hygiene intervention).

Data charting

Data extracted from the included articles included year of publication, authorship team, location, study design, population, and study setting. Additionally, the aspect(s) of sleep hygiene that each article addressed was identified (e.g., caffeine use, pre-bed routines). Results were then synthesised by sleep hygiene strategy. Data charting was conducted by author MS.

RESULTS

Selection of sources of evidence

Searches identified a total of 946 peer reviewed journal articles (after duplicate removal) that were screened based on title and abstract. Full text review was performed of 88 journal articles, of which 30 met the criteria for inclusion. See Figure 1 for an overview of screening procedures (PRISMA flowchart). Full text screening was performed by authors MS and SF. Any discrepancies were resolved by consulting with a third author (CG).

INSERT FIGURE 1

Characteristics of sources of evidence

Study design, location, year of publication, population, study setting, and outcomes are presented in Supplementary File 1. The following strategies had associated articles: alcohol use (n = 2), exercise (n = 10), light (n = 1), pre-bed state (n = 11), tobacco use (n = 3), and sleep hygiene education (n = 1). An additional two papers included both measures of sleep hygiene and sleep in a chronic pain population. No studies were found addressing any other sleep hygiene strategies in a chronic pain population.

Chronic pain populations included individuals with fibromyalgia (n = 3), non-specified chronic pain (n = 6), non-cancer related chronic pain of any kind (n = 4), chronic spinal pain (n = 1), chronic benign neck, low back and/or generalised pain (n = 2), chronic low back pain (n = 2), musculoskeletal chronic pain (n = 3), back pain, osteoarthritis, and/or rheumatoid arthritis (n = 1), Failed Back Surgery Syndrome (n = 1), chronic knee pain (n = 1), sickle cell disease (n = 1), orofacial pain (n = 1), chronic rheumatic conditions (n = 2), cancer (n = 1),

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and Parkinson’s disease (n = 1). Participants in the included studies included adults (n = 29) with one study including child participants (n = 1).

Synthesis of results

Each sleep hygiene strategy for which studies were identified is discussed. The strategies are listed based on those most commonly reported in the literature to least commonly reported.

Pre-bed state: Avoid anything that may alert you before bedtime

Eleven studies examined pre-bed state and sleep outcomes in patients with chronic pain [47-57]. There was methodological heterogeneity amongst these 11 studies. Of the studies that utilised a cross-sectional design, two investigated the impact of pre-sleep arousal on scores on the Insomnia Severity Index in participants with chronic pain [49, 51]. Both studies demonstrated that heightened pre-bed state, measured by greater pre-sleep arousal, was associated with higher scores on the Insomnia Severity Index, indicating impaired sleep. The study by Zaidel, et al. [57] used a cross-sectional design in older adults (>65 years old) diagnosed with chronic pain and reported that pre-bed state, measured as higher daily stress, was associated with poor sleep quality and quantity.. Daily stress was also associated with poor sleep quality in a sample of children diagnosed with sickle cell disease [56].

Mindfulness and meditation were also common amongst the studies that addressed pre-bed state and sleep [47, 52, 53, 55]. Mindfulness programs were assessed in populations of patients with chronic non-cancer pain [47], failed back surgery syndrome [52], chronic knee pain [53], and chronic low back pain [55]. There were mixed findings, with some studies identifying less sleep disturbance post-mindfulness intervention [47, 55], and the remaining two studies showing no benefit of mindfulness on sleep compared to a control condition [52] or listening to music [53].

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3 Relaxation was also investigated as a pre-bed state strategy [48, 50, 54]. Findings were again
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5 mixed with improvements in subjective sleep quality seen after using progressive relaxation
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7 in a sample of 19 participants with chronic pain [50] and in a sample of 36 participants with
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9 chronic back or joint pain [54]. Conversely, no improvement in sleep quality was seen in a
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11 sample of 12 participants with musculoskeletal pain who completed a pre-bed relaxation
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13 intervention [48].
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16 17 **Exercise: Avoid exercising to the point of sweating within 1h of going to bed**

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20 Ten studies assessed exercise as a sleep hygiene strategy, with mixed findings. Decreases in
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22 insomnia severity [58, 59] , decreases in sleep problems [60], and increases in sleep quality
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24 [61, 62] were found after some exercise interventions to increase activity during the day in
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26 participants living with chronic pain. Other studies however, found that higher daytime
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28 activity was associated with either no change in insomnia symptoms [63], poorer sleep
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30 quantity and quality in individuals with chronic pain [64-66].
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34 35 **Tobacco: Avoid alcohol, tobacco, caffeine within 4h of going to bed or after going to bed**

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38 Three studies investigated tobacco use and sleep outcomes in patients with chronic pain [67-
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40 69]. Cross-sectional study designs were used in all three studies, with both Burris, et al. [68]
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42 and Khan, et al. [67] doing retrospective reviews of clinical care data from patients
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44 experiencing chronic pain. In both studies sleep disturbance was significantly worse in
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46 participants that smoked compared to those that didn't, as measured by the PSQI [68] and a
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48 sleep-related question from the Patient-Reported Outcome Measurement information System
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50 [67]. Similar results were seen in the study conducted by Stipelman, et al. [69], with data
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52 from a National Health Interview Survey. Smokers were more likely to have short sleep
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54 duration (<6h) compared to non-smokers in a sample of 22, 850 patients with chronic
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Sleep hygiene

Two studies measured the relationship between the use of ‘sleep hygiene practices’ as a whole and sleep outcomes in individuals with chronic pain [70, 71]. Emery, et al. [71] conducted a study in which 60 participants completed a survey including the Sleep Hygiene Awareness and Practice Scale and the Pittsburgh Sleep Quality Index (PSQI). They found that participants with musculoskeletal chronic pain reported better sleep hygiene than those with comorbid major depressive disorder and musculoskeletal pain. However regardless of sleep hygiene use, all participants had poor sleep onset latency and sleep quality. Likewise, in a study of adolescents with and without chronic pain [70], those with chronic pain had poorer sleep quality despite a similar use of sleep hygiene amongst participants.

Alcohol: Avoid alcohol, tobacco, caffeine within 4h of going to bed or after going to bed

Alcohol use and sleep was investigated in samples of patients with chronic pain in two studies [72, 73]. Graham and Streitel [72] had 108 college students with any reported type of chronic pain complete a survey about alcohol use and sleep and found that increased alcohol use was associated with poorer sleep. Similarly, Miller, et al. [73] found that an increase in alcohol consumption resulted in increased sleep latency in a sample of 23 students with fibromyalgia who completed 14-day alcohol and sleep diaries.

Education

One study was identified that investigated the influence of education about healthy sleep as a sleep hygiene strategy [74]. Berry et al. (2015) conducted a randomised controlled trial with 85 participants with chronic non-cancer pain and found that a four-week sleep hygiene education program improved sleep onset latency in people living with chronic pain compared to a control group of people living with chronic pain who did not receive the same education program.

Sleep environment: A comfortable bedroom (temperature, light, noise)

Only one study identified in this review investigated optimising the sleep environment [75].

Morning bright light was used in 37 participants with chronic back pain for 13 days. It was found that subjective sleep quality improved post-bright light treatment, compared to pre-treatment.

No evidence found

No studies included in this review presented information on napping, consistent bed and wake times, caffeine use, pre-bed activities (not mood related), bed and bedroom use, uncomfortable bed/bedding, pre-bed work, or pre-bed routines.

Discussion

The aim of this scoping review was to map the state of the existing literature examining sleep hygiene strategies in individuals with chronic pain. While there was a range of literature supporting the use of sleep hygiene strategies in individuals with chronic pain, the heterogeneity of sleep hygiene strategies used, and chronic pain samples studied limits the generalisability of current findings. This finding is important to consider given that sleep hygiene strategies are commonly recommended for those with chronic pain as part of behavioural treatments [76].

Thirty studies were found that supported the use of six specific sleep hygiene strategies (education, exercise, limiting alcohol use, limiting tobacco use, pre-bed state, and sleep environment), with the most commonly reported strategies being the management of pre-bed state and use of daytime exercise. Standard sleep hygiene advice relating to pre-bed state highlights the need to avoid thinking, planning and worrying before sleep [31]. The 11 identified studies that addressed pre-bed state suggest that using strategies such as relaxation [48, 50], mindfulness [47, 52], and meditation and music [53] can improve sleep quality and

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decrease sleep disturbance in people with chronic pain. However, it must be noted that many of the included studies did not require these relaxation strategies to be performed immediately prior to bed (i.e., these activities were performed at any time of day). It is possible that the impact of these activities on pre-bed state (and potentially on subsequent sleep) would be greater if performed within the context of a specific sleep hygiene intervention (i.e., if relaxation or mindfulness activities were performed in the hour or two before bed). The studies for pre-bed state as a sleep hygiene strategy included participants from a wide range of age groups. This is an important consideration when interpreting the impact of this sleep hygiene strategy, as there are age-related changes in sleep across the lifespan [77], which may mean that the sleep of different age groups are differentially impacted by sleep hygiene strategies. Further, given that chronic pain is typically associated with high levels of stress and anxiety [78], it is likely that interventions designed to improve pre-bed state may be of particular importance for improving sleep in this population [79].

Conflicting results were found for exercise as a sleep hygiene strategy in people with chronic pain. Given that there was a high level of heterogeneity in the types and duration of exercise measured in each study, no one study can provide recommendations for the optimal type or duration of exercise for improving sleep in individuals with chronic pain. It is also likely that the effectiveness of exercise as a strategy for improving sleep differs based on the type of chronic pain experienced by the individual, as well as the type of exercise (e.g. high intensity vs low intensity). This corresponds to previous literature showing that overactivity can exacerbate symptoms of chronic pain [64]. Further, it is important to note that while the sleep hygiene guidelines by Mastin, et al. [31] recommend avoiding exercise within one hour of going to bed, a recent systematic review and meta-analysis of 23 articles found that overall, evening exercise did not influence sleep quality [80]. Given that the exact timing of exercise was not investigated in the studies identified in the present review, it is unknown if

there is an optimal time of day to exercise for people living with chronic pain in relation to sleep outcomes. As such, there is a need for future research to address both the timing, type and duration of exercise used by individuals with different types of chronic pain when considering the impact on subsequent sleep. This research will inform targeted recommendations for exercise as a sleep hygiene strategy for individuals with chronic pain.

Alcohol and tobacco intake was also investigated in the reviewed studies, with sleep disturbances in individuals with chronic pain associated with increased tobacco use and alcohol use [67-69, 72, 73]. Of note however, is that the sleep hygiene recommendation is to avoid these substances in the four hours prior to bed [31]. In the studies included in this review, however, overall daytime consumption of alcohol or tobacco was measured rather than specific timing of consumption (i.e., whether alcohol/tobacco were consumed close to bedtime). Therefore, timing of alcohol and tobacco use, rather than restriction of alcohol use, is the critical question in the context of a sleep hygiene strategy and should be considered within future research. This research is particularly important given that alcohol may negatively interact with pain medications [72], and tobacco can contribute to higher pain intensity [81]. Furthermore, alcohol has reportedly been used to self-medicate in some individuals with chronic pain [82], and there may therefore be reluctance to decrease or stop use in the absence of a pain management alternative.

Despite identifying existing literature that supports the use of certain sleep hygiene strategies in individuals with chronic pain, caution must be taken when recommending these strategies due to the limited scope of the literature. Firstly, there are diagnosis-specific characteristics found in different chronic pain conditions [83]. For example, people with nociplastic conditions such as fibromyalgia or complex regional pain syndrome are known to have higher sensory sensitivity, and suffer from fatigue and insomnia more than people with other pain conditions [26]. This is likely to influence the efficacy of sleep hygiene strategies

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for this specific chronic pain population. Further, it is likely that were these sleep hygiene strategies to be recommended, some modifications may be necessary to tailor the recommendations for individuals with chronic pain. For example, one sleep hygiene strategy involves avoiding alerting activities before bedtime, such as the use of a mobile phone, internet, or video games. However, such tasks have been shown to be a distraction from pain symptoms [84, 85]. Therefore, a suggestion to avoid these tasks before bed may increase awareness of pain symptoms before bed which would have a negative impact on sleep. A pre-bed activity that is distracting from pain but not alerting may be an appropriate alternative for individuals with chronic pain. Modifications such as this should be considered for all sleep hygiene strategies.

No studies investigated the use of the remaining eight sleep hygiene strategies (pre-bed work; pre-bed routine; use of bed for activities other than sleep or sex; uncomfortable bed or bedding; caffeine; pre-bed alerting activities; napping; and consistent bed/wake times). A priority for future research is to investigate the efficacy of these strategies for improving sleep in chronic pain populations. An important first step could be to investigate the caffeine-related strategy, as caffeine is known to play a role in pain management due to the adjuvant analgesic effects[86, 87]. Much like alcohol and tobacco, caffeine is best avoided in the four hours prior to bed according to the general sleep hygiene guidelines [31]. However, no studies assessing this strategy in a chronic pain population were identified in this review. Further, several studies have highlighted that those with chronic pain consumed significantly more coffee than those without chronic pain [88-90]. This highlights the need for further investigation of the relationship between caffeine use, chronic pain, and sleep, given the high amount of use of caffeine in a chronic pain population.

The limitations of this review must be acknowledged. This is a scoping review, designed to overcome the evidence bias that may be present in a narrative review but with a

broader search than a systematic review in order to understand a wider research area [45]. A limitation of the search strategy is that terminology used to discuss sleep hygiene throughout the literature was not consistent and many studies did not use the term sleep hygiene. While the search strategy was widened to include terms relating to specific strategies, it is possible that some articles were missed.

The review highlights that while sleep hygiene is promoted as a non-pharmacological strategy for improving the sleep of those with chronic pain, there is limited research on the efficacy of these strategies in individuals with chronic pain. While creating, evaluating, and promoting targeted sleep hygiene guidelines for people living with chronic pain is a goal, more research is needed. Firstly, assessment of the efficacy of current sleep hygiene strategies in individuals with chronic pain is required. Specifically, certain activities (e.g., exercise) would ideally be investigated in the context of the pre-bed period, taking account of timing. While research on some sleep hygiene strategies was identified, only tentative support could be provided due to the heterogeneity of type and duration of sleep hygiene strategies used. Therefore, studies should be designed to evaluate the efficacy of certain sleep hygiene strategies in individuals with chronic pain. The differences between chronic pain conditions must also be considered, in addition to individuals experiencing chronic pain as a symptom of a treatment (e.g. chronic pain associated with chemotherapy⁷¹). Following additional studies, systematic reviews and meta-analyses should be prioritised to assess effectiveness of the sleep hygiene strategies investigated in the chronic pain populations represented by the literature. Finally, qualitative approaches will be critical in understanding the lived experience of chronic pain and the use of sleep hygiene strategies.

This scoping review mapped the current literature addressing sleep hygiene in individuals experiencing chronic pain. Limited literature was identified, and while some strategies show promise for improving sleep in people living with chronic pain, the timing of

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the strategy use/implementation was not examined. Given the relationship between sleep quality and pain, as well as the fact that sleep hygiene is commonly promoted to people with chronic pain, future research into the efficacy of sleep hygiene programs is needed. This is necessary to ensure that advice given to people living with chronic pain is evidence-based and will lead to improvements in sleep.

Ethical approval: This study does not involve participants and ethical approval was not required.

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Conflict of interest: The authors declare no conflicts of interest.

Data sharing: Data sharing not applicable as no datasets generated and/or analysed for this study.

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Figure 1. Screening Process

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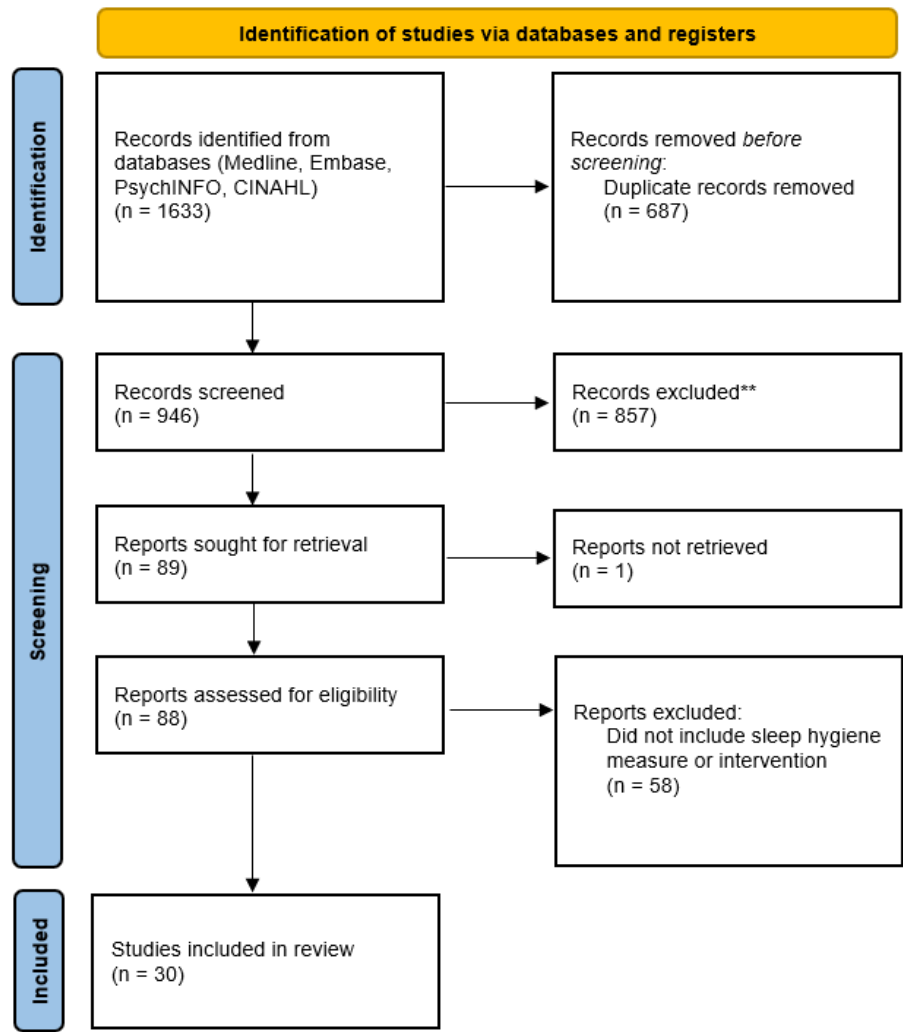


Figure 1. Screening process

Supplemental File 1. Data Charting Table

Author	Year	Location	Study design	Sample size and age (M±SD)	Sleep measure	Sleep hygiene-related intervention	Findings
Sleep hygiene strategy	All sleep hygiene strategies						
	Emery et al.	2014	Canada	Multi-component study including qualitative interviews, cross-sectional survey, and observational data	60 (44 female) adults with and without major depressive disorder. Age 46.0±9.2 years.	Cross-sectional component of study included the completion of the SHAPS, PSAS, and the PSQI. Participants also completed daily sleep diaries.	Reporting on sleep hygiene practices
							PSQI (p>0.10) MDD group: 15.48(±3.68) Non-MDD group: 14.84(±4.06)
							SHAPS (p=0.06) MDD group: 35.61(±15.30) Non-MDD group: 28.31(±13.80)
							PSAS – somatic (p=0.070) MDD group: 16.38(±5.12) Non-MDD group: 14.12(±4.27)
							PSAS – cognitive (p=0.009) MDD group: 21.11(±7.66)

								Non-MDD group: 16.44(±5.30)
Walker et al.	2010	United States	Cross-sectional observational design	51 adolescents (22 female) receiving chemotherapy treatment for cancer. Aged 14.2±2.7 years.	ASHS, 7-day sleep diary	Outcomes compared on the Adolescent Sleep Hygiene Scale		Sleep environment subscale (p≤.001) Cancer group: 5.0(±0.9) Healthy controls: 5.5(±0.6)
				Compared to a sample of 20 healthy norms.				Sleep stability subscale (p≤.001) Cancer group: 3.7(±1.1) Healthy controls: 4.3(±0.7)
								ASHS total score (p≤.001) Cancer group: 4.7(±0.5) Healthy controls: 5.0(±0.4)
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Berry et al.	2015	Canada	Sleep education Between-subject randomised controlled trial	85 (52 female) patients with non-cancer pain randomly allocated	Intervention group with one-on-one didactic	Intervention consisted of one-on-one didactic sleep		Sleep latency (week 4)* (p < .02)
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to a treatment group ($n=44$, aged 50.4 ± 10.4 years) or a control group ($n=41$, aged 48.5 ± 11 years). session including practical steps for improving sleep, control group. hygiene sessions with practical steps for improving sleep. Sleep hygiene group: 93.9 (± 42.6) mins Control group: 118.4 (± 45.1)

Sleep quality (week 4)
Sleep hygiene group: 2.8 (± 0.8)
Control group: 2.9 (± 0.7)

Time in bed (week 4)
Sleep hygiene group: 7.5 (± 1.6)
Control group: 7.2 (± 1.1)

Napping - *no articles found*

Consistent bed and wake time - *no articles found*

	Exercise						
Andrews et al.	2014	Australia	Observational, prospective, within-person study design	50 (30 female) patients with non-cancer related chronic pain. Aged 54.2 ± 10.7 years.	Activity monitor and questionnaire completion over five days	Comparison of daily physical activity and sleep outcomes	Higher daytime activity associated with greater overnight wakefulness

							(β =.29, $t_{88.84}=2.09$, $P=.04$, 95% CI=0.0015 to 0.06)
Asih et al.	2014	United States	Prospective within-subject study design	262 (87 female) patients with chronic disabling occupational musculoskeletal disorders. Aged 44.9±10.9 years.	ISI	Quantitatively directed exercise progression program including approximately 4-6h activity per day over 4-8 weeks.	53.4% of participants moved to a lower category on the Insomnia Severity Index at the end of treatment.
Evans et al.	2013	United States	Exploratory randomised usual-care waitlist-control design	26 female patients with rheumatoid arthritis, aged 28.3±3.9 years.	Weekly rating of trouble with sleeping	Participation in yoga program. Data collected at three timepoints (baseline, post-treatment, 2 month follow up)	No significant differences in sleep outcomes for participants in the yoga group ($p = .100$)
Hall et al.	2019	United States	Prospective baseline, pre- and post- intervention design	33 (25 female) patients at a pain management clinic, aged 51.4± 11.3 years.	SPI II completed baseline, pre- and post-intervention	Participation in a 10-week yoga program. . One third of participants (N = 11) completed pre-	SPI II Baseline (N = 33): 50.9 ± 21.3 Pre-intervention (N = 27): 49.4 ± 20.5

						and post-intervention measures.	Post-intervention (N = 11): 37.9 ± 23.1
Jones et al.	2012	United States	Parallel-group randomised controlled trial	98 (91 female) individuals diagnosed with fibromyalgia. Average age 54 years (no SD provided, range 40.7-74.1 years).	PSQI	8-form Yang-style Tai chi program compared to an education control	PSQI global score Tai chi group: -2.0 points Control group: 0.03 points
McGovney et al.	2020	United States	Observational, prospective, within-person study design	160 (150 female) participants diagnosed with fibromyalgia who reported insomnia complaints. Aged 52.4±11.7 years)	Actigraphy	14-day data collection of usual physical activity	Reduced total sleep time, sleep latency, wake after sleep onset, and sleep efficiency after afternoon activity, (p < .001 for all variables), and early evening activity (p < .001 for all variables)
Nguy et al.	2020	Australia	Observational cross-sectional design	52 (16 female) participants with Parkinson's disease, aged 67.8±7.8 years.	PSQI and actigraphy	7-day data collection of usual physical activity, sleep, and pain	Increased physical activity associated with increased pain (p<.05) Poor sleep associated with

							increased pain ($p<.05$)
Skarpsno et al.	2018	Norway	Longitudinal design	21, 847 participants (11,909 female) with and without chronic pain. Age of chronic pain group ($n=5305$) 47.6 ± 12.0 , age of no chronic pain group ($n=6605$) 47.6 ± 12.0 (overall sample mean not provided)	Questions on insomnia symptoms	Historical data of a sample of the general population including measures of chronic pain, physical activity, and insomnia at baseline (1955-97) and followed up in 2006-08.	No combined effect of physical inactivity and ≥ 5 pain sites on risk of insomnia (RERI: 0.88 (95% CI: $_{-0.85, 2.60}$)) With 1-4 pain sites, physical activity resulted in a lower risk of insomnia ($p<0.05$).
Tang et al.	2014	United Kingdom	Observational cross-sectional design	119 (88 female) patients with chronic pain and insomnia, aged 46.0 ± 10.9 .	Sleep diary and actigraphy	7-day data collection of usual sleep and physical activity	Sleep quality predicted physical activity ($p= .017$)
Wiklund et al.	2018	Sweden	Randomised controlled trial	185 (participant sex not reported) patients with chronic benign neck, low back, and/or generalized pain, aged 54.2 ± 10.2 years.	ISI	Participants randomly allocated to complete 7-8 weeks of treatment (exercise or stress management) or control).	Post-intervention ISI *= significantly different from baseline measurement ($p<.05$) Exercise group: $11.19 \pm 6.27^*$ Stress management

group: $12.22 \pm 6.38^*$
Control group:
 12.59 ± 7.13

		Alcohol use						
	Graham & Streitel	2010	United States	Cross sectional design	362 (265 females) participants, aged 20.6 ± 1.6 years, with chronic pain ($n=108$) and without chronic pain ($n=254$).	PSQI	Participants completed a survey on usual experience of chronic pain, and usual sleep quality and alcohol use	Alcohol use predicted poor sleep quality $b = .29$, $p < .01$
	Miller et al.	2018	United States	Observational, prospective, within-person study design	73 adults (68 women) reporting symptoms of chronic pain and insomnia related to fibromyalgia, aged 51.3 ± 12.0 years.	Sleep diary	14-day data collection of usual alcohol use and sleep patterns	Each alcoholic drink consumed resulted in an increased sleep latency of 5.0 minutes.
		Tobacco use						
	Burris et al.	2013	United States	Cross-sectional design	48 (all female) patients experiencing orofacial pain, aged 41.1 ± 13.3 years.	PSQI	Retrospective chart review of new-patient questionnaires on sleep quality, and smoking behaviour.	PSQI global score* ($p > .05$) Non-smokers: 1.44 (1.08) Smokers: 2.00 (0.93)

Khan et al.	2019	United States	Longitudinal design	8584 patients attending the Stanford Pain Management Center from 2013-2017. Participants split into smokers ($n=727$) aged 47.9 ± 12.9 years, and non-smokers ($n=5254$) aged 49.4 ± 16.5 years (overall sample age not provided).	PROMIS	Participants completed PROMIS (with sleep and smoking-related questions) at two time points: baseline, and time 2 (6-8 weeks following baseline) after they have received a range of recommendations for pain management.	Sleep disturbances significantly worse in smokers than non-smokers at baseline and time 2: $p < .001$
Stipelman et al.	2013	United States	Cross-sectional design	22,850 (11,640 females) participants from the National Interview Survey. Aged 18+ (mean age not provided) Participants were split into 2 groups, those with a chronic rheumatic condition causing pain ($n=1417$ females)	Questions on sleep duration from the National Health Interview Survey	Questions from the National Health Interview Survey on usual smoking behaviour.	Reported <6h sleep/night Smokers: 25.4 % Non-smokers: 15.2%

and those without a
chronic rheumatic
condition (n=11, 224
females)

Caffeine - *no articles found*

Pre-bed alerting activities (e.g., video games, internet) - *no articles found*

Pre-bed state (e.g., stress, anger, worry, rumination)

Brintz et al.	2020	United States	Mixed-methods, single-group, pre-post design	23 adults (17 female) experiencing non-cancer chronic pain, Mean age 53 years (no SD provided).	PSQI and actigraphy	Participants completed four weekly sessions of mindfulness-based stress reduction	Sleep disturbance* (p>.05) Pre-intervention: 56.52 (±7.79) Post-intervention: 51.83 (±9.75)
Brown et al.	2014	Canada	Case series study	12 patients (9 women) with a diagnosed musculoskeletal condition and self-reported problems with sleep, aged 58.4±9.5 years.	PSQI and actigraphy	Participants completed 7-days of baseline data collection, were taught a hand self-Shiatsu method, and completed two follow ups (2 and 8 weeks)	No significant differences in PSQI or actigraphy outcomes from baseline to follow up (no figures reported).
Byers et al.	2016	United States	Cross-sectional design	48 adults (36 female) with chronic pain,	ISI	Participants completed a	13% of variance in scores on ISI

				aged 51.6±11.9 years.		questionnaire on pain, cognition, and sleep.	explained by cognitive and somatic scores on the PSAS (p=.001)
Chen & Francis	2010	Australia	Randomised controlled trial	19 participants (13 female) with current chronic pain, aged 39.3±13.0 years).	VAS relating to sleep quality	Participants completed 1 week of baseline data collection followed by 6 weeks of either treatment (abbreviated progressive relaxation technique and guided imagery intervention) or control.	Sleep quality VAS ratings Intervention group: 75% of participants saw improvement Control group: 28.57% of participants saw improvement
Dillon et al.	2012	United States	Cross-sectional	48 adult (36 female) outpatients with chronic pain, aged 51.6±11.9 years.	ISI	Inter-group comparison of cognitive and somatic pre-sleep arousal, based on Insomnia Severity Index (ISI) scores.	PSAS item “worry about falling asleep”* (p<.05) Participants with moderate – severe ratings on ISI: 3.2(±1.6)

							Participants with mild ratings on ISI: 2.3(±1.2)
Esmer et al.	2010	United States	A single-center, prospective, randomized, singleblind, parallel-group clinical trial	25 (11 women) patients with persistent leg pain, back pain, or both. Participants assigned to intervention ($n=15$, aged 55.2 ± 11.2 years) or control ($n=10$, aged 54.9 ± 9.5 years). Overall mean age not provided.	PSQI	Participants allocated at baseline to receive mindfulness-based stress reduction therapy or a control for 8-weeks.	Abridged PSQI Intervention group: 2.4 (±0.8) Control group: 2.3 (±0.9)
Innes et al.	2018	United States	Randomised controlled trial	22 (15 female) adults with symptomatic knee osteoarthritis pain, aged 58.5 ± 1.4 years.	PSQI	Participants randomised to a mantra meditation or a music listening program for 8 weeks.	PSQI global score ($p = .23$) Meditation group: 9.78 (±3.24) Music listening group: 8.09 (±2.21)
Linton et al.	1985		Three group pre- and post-test design	28 (15 female) participants with current pain in back or joints. Participants were randomly allocated to a waiting list control ($n=10$, age mean	Questions on sleep latency, quality, and number of awakenings which were combined	Comparison of waitlist control, regular treatment, and behavioural treatment (including applied	Significantly greater improvements seen in the behavioural treatment group compared with waitlist control

					39.2 years, no SD provided), regular treatment (<i>n</i> =10, age mean 37.6 years, no SD provided), or behavioural training and regular treatment (<i>n</i> =8, age mean 43.1 years, no SD provided)	into one overall sleep outcome metric.	relaxation) groups ,	(<i>p</i> =.020) and regular treatment (<i>p</i> =.049).
	Morone et al.	2008	United States	Qualitative design	27 adults (14 female) with chronic lower back pain, aged 74.3±5.3 years.	Diary with qualitative data on sleep	8-week mindfulness meditation program.	Main themes: <ul style="list-style-type: none">• Pain reduction Improvement in attention skills <ul style="list-style-type: none">• Improved sleep• Wellbeing• Barriers to meditation• Processes of meditation
	Valrie et al.	2007	United States	Prospective observational study	20 children (13 female) with sickle cell disease, mean age 10.1±10.1 years.	VAS relating to sleep quality and sleep duration	Daily diary study in children with sickle cell disease.	Greater stress during the day associated with shorter sleep periods ($\beta = -0.13, p = .04$)
	Zaidel et al.	2021	United States	Cross-sectional design	4,201 (2,827 females) adults with	PSQI	Participants completed a	Sleep quality (<i>p</i> <.001)

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diagnosed back pain,
osteoarthritis, and/or
rheumatoid arthritis,
aged over 65 years
(no mean or SD
provided).

survey on
sleep and daily
stress.

Low stress: 50.2
(poor sleep
quality); 73.3
(good sleep
quality)
Medium stress:
41.9 (poor sleep
quality); 24.5
(good sleep
quality)
High stress: 7.7
(poor sleep
quality); 1.5
(good sleep
quality)

Sleep duration
($p < .001$)
Low stress: 74.8
(poor sleep
duration); 67.0
(good sleep
duration)
Medium stress:
23.4 (poor sleep
duration); 29.7
(good sleep
duration)
High stress: 1.3
(poor sleep
duration); 2.5

								(good sleep duration)
Use of bed for activities other than sleep or sex - <i>no articles found</i>								
Uncomfortable bed/bedding - <i>no articles found</i>								
Sleep environment (e.g., light, heat)								
Burgess et al.	2018	United States	Single-arm trial	37 (10 females) veterans with diagnosed chronic lower back pain, aged 48.4±14.1 years.	PSQI and actigraphy	Participants completed a 7-day baseline followed by 13 days of a 1-hour morning bright light treatment self-administered at home.	Total sleep time Pre-intervention: 402.47 (±75.66) mins Post-intervention: 383.40 (±67.46) mins Bedtime* (p>.05) Pre-intervention: 23:25 (±1.80) Post-intervention: 22:55 (±1.75) Dim light melatonin onset (DLMO)* Pre-intervention: 19:58 (±1.57) Post-intervention: 19:11 (±1.46)	

Pre-bed work - *no articles found*

Pre-bed routine - *no articles found*

Note. M – Mean. SD – Standard Deviation. SHAPS – Sleep Hygiene Awareness and Practice Scale; PSAS – Pre-Sleep Arousal Scale; PSQI – Pittsburgh Sleep Quality Index; MDD – Major Depressive Disorder; ASHS – Adolescent Sleep Hygiene Scale; VAS – Visual Analogue Scale; SPI II – Sleep Problem Index II; ISI – Insomnia Severity Index; PROMIS – Patient Reported Outcomes Measurement Information System; DLMO – Dim Light Melatonin Onset.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	n/a
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	9
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	10
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	n/a
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	n/a

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	21
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	10
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Supplementary table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	14
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

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